Project Schedule and Public Involvement Plan M1

Needs and Opportunities M2

Identification of Alternatives M3

Evaluation of Alternatives M4

Regional Commuter Rail/High-Capacity Transit Plan M5

Final Report M6

MILESTONE 5
REGIONAL COMMUTER RAIL/ HIGH CAPACITY TRANSIT PLAN

January 2003

HIGH-CAPACITY TRANSIT PLAN
Maricopa Association of Governments

5.0 Executive Summary

This Milestone Report is the fifth of six milestone reports that will be prepared for the Maricopa Association of Governments' (MAG) High Capacity Transit Plan. The Milestone 5 document is comprised of three tasks:

- Task 13: Identify an Integrated High Capacity Transit Network and Define Preliminary Operating Characteristics
- Task 14: Estimate Ridership and Potential Revenues; Estimated Operating and Capital Costs
- Task 15: Develop Implementation Strategies and Action Plan

This report is organized as follows:

- Section 5.1 – Refinement of Ridership and Cost Estimates
- Section 5.2 – MAG Region High Capacity Transit Network
- Section 5.3 – Implementation Plan

The primary result of Task Thirteen is the identification of the MAG Recommended High Capacity Transit Network. This recommended network is the result of an evaluation process performed in Milestone 4 and refined in this report. The network is designed to serve the major activity and employment centers existing and planned in the MAG region. The description of the recommended network includes discussions about the types of service proposed including technology and headways, the coordination of service and individual corridors with other corridors, and the impact these new services will have on the existing transit network and land use development patterns.

Task Fourteen focuses on the refinement of the ridership estimates and capital and operating costs estimates made in Milestone 4. These figures have been refined to incorporate the effect of new population forecasts for the MAG region, as well as refinements to catchment areas and unit cost rates. This task also includes alternative operating scenarios and rail vehicle technologies for the commuter rail corridors.

Task Fifteen presents an Implementation and Phasing Plan for each of the 15 recommended high capacity transit corridors. General phasing guidelines for each of the three recommended high capacity transit technologies are provided along with suggested phasing steps to provide high capacity transit service in each of the recommended corridors. The conclusion of this task includes an Action Plan detailing specific tasks to be fulfilled during the next three to five years as the high capacity transit network is finalized.

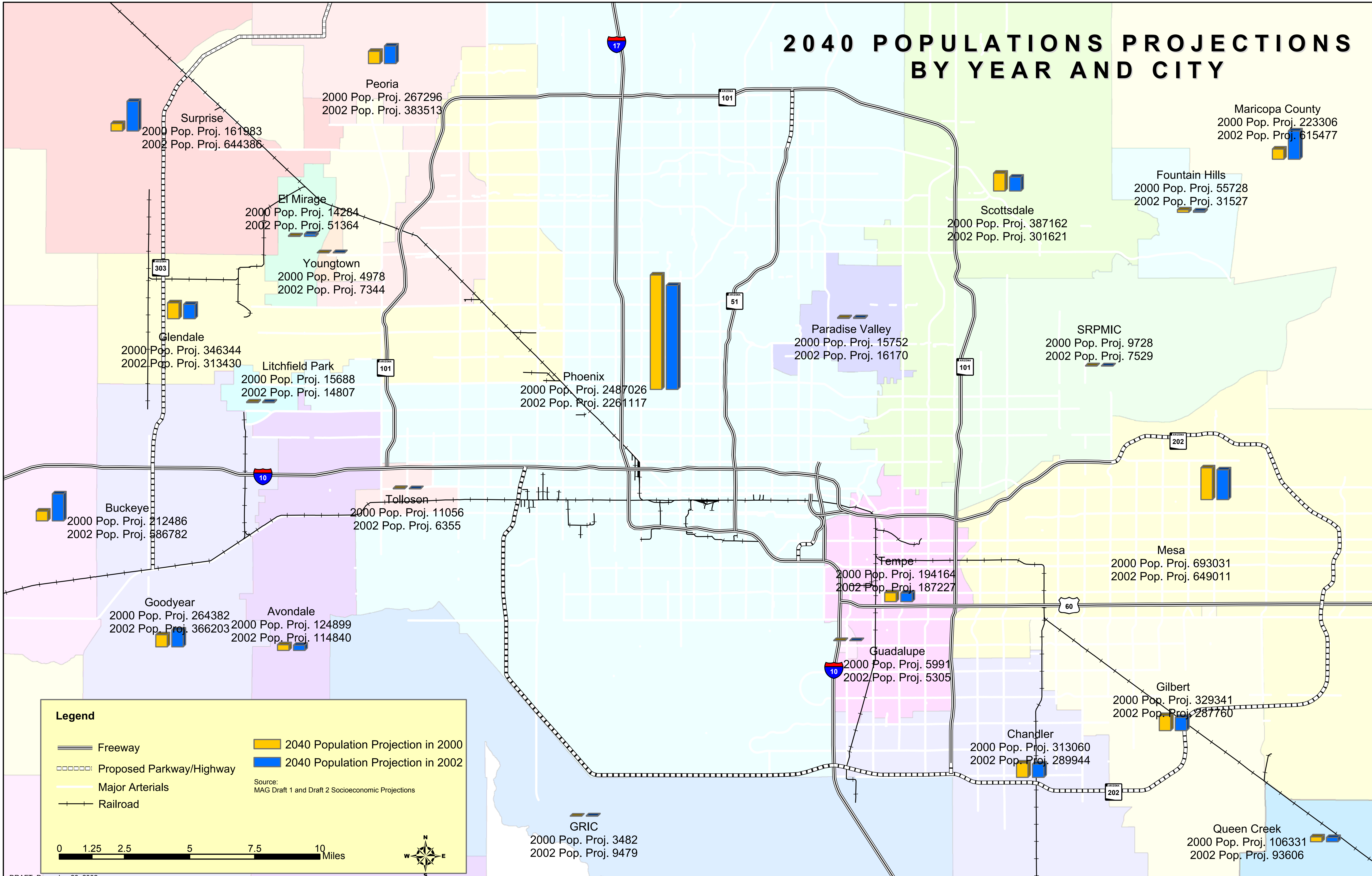
New Population Projections

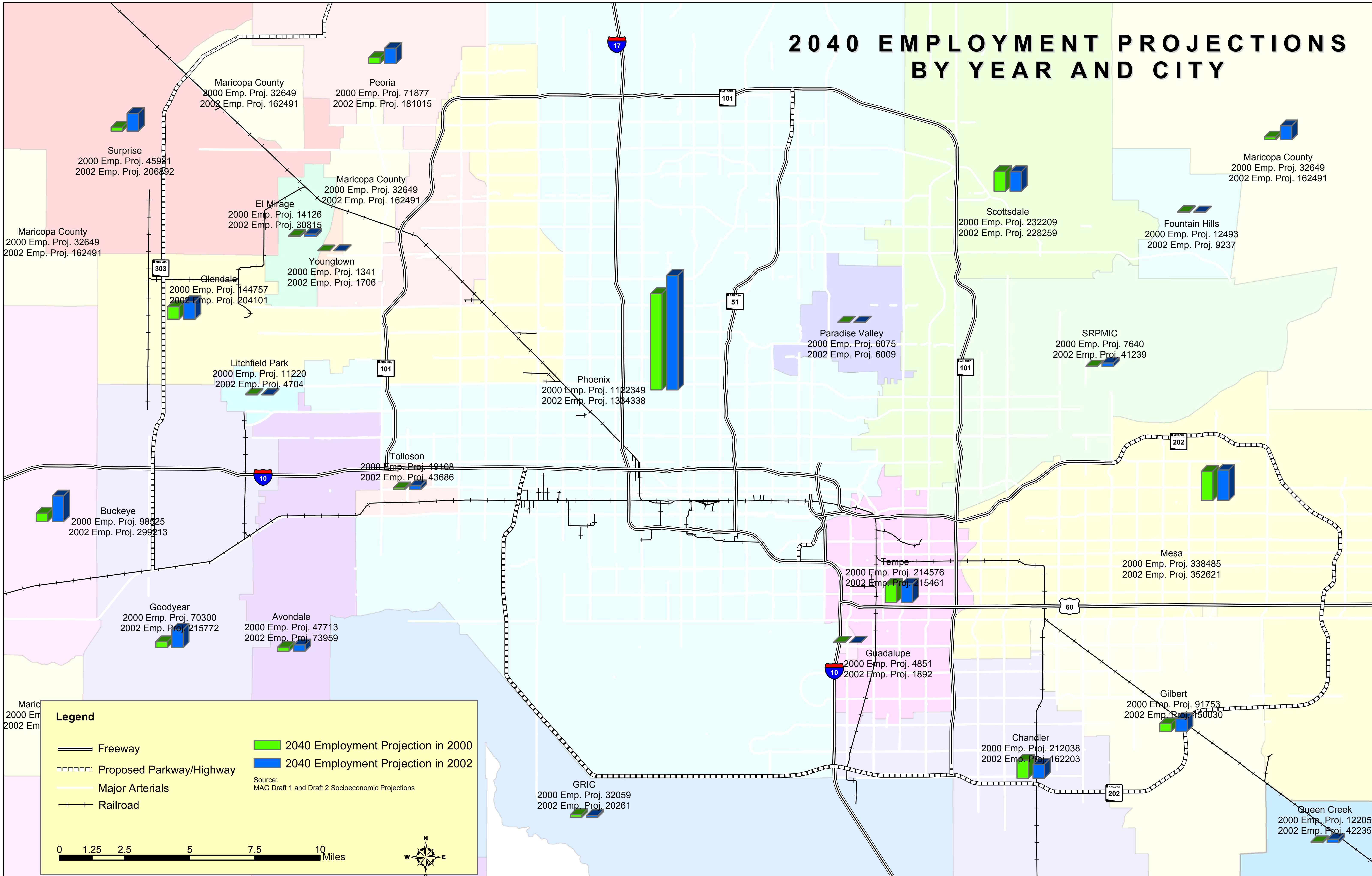
An important aspect of this report is the incorporation of revised population and employment forecasts for the MAG region to the Year 2040. In Milestone 4 regionally adopted population and employment projections were used to estimate ridership on the commuter rail, light rail (LRT), and bus rapid transit (BRT) corridors identified for evaluation. These population and employment projections were based upon a Year 2040 buildout population of 6.4 million residents in the MAG region. The revised population projections provided prior to the development of Milestone 5 have increased the overall Year 2040 population in the MAG region to 7.4 million residents (Draft 2 Socioeconomic Projections). The majority of this new growth occurs in the Western MAG region, specifically in cities such as Buckeye, Surprise and Goodyear. Several areas and municipalities in the MAG region have seen a reduction in future population levels as a result of the new projections, specifically in the East Valley and portions of Phoenix, largely as a result of land use plan changes.

Exhibits 5.0-1 and 5.0-2 illustrate the change in the projected population and employment in each city between the previous regionally adopted population estimates and the revised draft estimates. Exhibit 5.0-3 illustrates the difference in the population levels between 2000 and 2040 by Traffic Analysis Zone (TAZ).

The largest change from the Milestone 4 forecasts is input data from the new population projections. These suggest higher overall growth, with total population around 15 percent higher than previously forecast. The distribution of growth is also different, with much higher rates in the West Valley area, while growth is reduced in the central and East Valley areas. Exhibit 5.1-1 on page 2 shows the change in population projections between those used in Milestone 4 and those used here in Milestone 5. Several major changes have resulted from the new forecasts that have a major impact upon commuter rail boarding projections. The changes noted below are a percentage change from the previous forecasts:

- Buckeye population increase of 276 percent
- Surprise population increase of 298 percent
- El Mirage population increased by 260 percent
- Mesa population reduced 6.4 percent
- Queen Creek population reduced 12 percent
- Gilbert population reduced 13 percent
- Chandler population reduced by 7.5 percent


2040 POPULATIONS PROJECTIONS
BY YEAR AND CITY
Peoria
2000 Pop. Proj. 267296
2002 Pop. Proj. 383513
Surprise
2000 Pop. Proj. 161983
2002 Pop. Proj. 644386
El Mirage
2000 Pop. Proj. 14284
2002 Pop. Proj. 51364
Youngtown
2000 Pop. Proj. 4978
2002 Pop. Proj. 7344
Glendale
2000 Pop. Proj. 346344
2002 Pop. Proj. 313430
Litchfield Park
2000 Pop. Proj. 15688
2002 Pop. Proj. 14807
Phoenix
2000 Pop. Proj. 2487026
2002 Pop. Proj. 2261117
Paradise Valley
2000 Pop. Proj. 15752
2002 Pop. Proj. 16170
Scottsdale
2000 Pop. Proj. 387162
2002 Pop. Proj. 301621
Fountain Hills
2000 Pop. Proj. 55728
2002 Pop. Proj. 31527
Maricopa County
2000 Pop. Proj. 223306
2002 Pop. Proj. 615477
SRPMIC
2000 Pop. Proj. 9728
2002 Pop. Proj. 7529
Buckeye
2000 Pop. Proj. 212486
2002 Pop. Proj. 586782
Tolleson
2000 Pop. Proj. 11056
2002 Pop. Proj. 6355
Goodyear
2000 Pop. Proj. 264382
2002 Pop. Proj. 366203
Avondale
2000 Pop. Proj. 124899
2002 Pop. Proj. 114840
Tempe
2000 Pop. Proj. 194164
2002 Pop. Proj. 187227
Mesa
2000 Pop. Proj. 693031
2002 Pop. Proj. 649011
Guadalupe
2000 Pop. Proj. 5991
2002 Pop. Proj. 5305
Gilbert
2000 Pop. Proj. 329341
2002 Pop. Proj. 287760
Chandler
2000 Pop. Proj. 313060
2002 Pop. Proj. 289944
GRIC
2000 Pop. Proj. 3482
2002 Pop. Proj. 9479
Queen Creek
2000 Pop. Proj. 106331
2002 Pop. Proj. 93606
17
101
303
51
10
202
60
Legend
Freeway
Proposed Parkway/Highway
Major Arterials
Railroad
2040 Population Projection in 2000
2040 Population Projection in 2002
Source:
MAG Draft 1 and Draft 2 Socioeconomic Projections
0 1.25 2.5 5 7.5 10 Miles
N
W E
S
DRAFT: December 26, 2002


2040 EMPLOYMENT PROJECTIONS
BY YEAR AND CITY
Maricopa County
2000 Emp. Proj. 32649
2002 Emp. Proj. 162491
Peoria
2000 Emp. Proj. 71877
2002 Emp. Proj. 181015
Surprise
2000 Emp. Proj. 45981
2002 Emp. Proj. 206892
Maricopa County
2000 Emp. Proj. 32649
2002 Emp. Proj. 162491
El Mirage
2000 Emp. Proj. 14126
2002 Emp. Proj. 30815
Maricopa County
2000 Emp. Proj. 32649
2002 Emp. Proj. 162491
Youngtown
2000 Emp. Proj. 1341
2002 Emp. Proj. 1706
Glendale
2000 Emp. Proj. 144757
2002 Emp. Proj. 204101
Litchfield Park
2000 Emp. Proj. 11220
2002 Emp. Proj. 4704
Phoenix
2000 Emp. Proj. 1122349
2002 Emp. Proj. 1334338
Scottsdale
2000 Emp. Proj. 232209
2002 Emp. Proj. 228259
Maricopa County
2000 Emp. Proj. 32649
2002 Emp. Proj. 162491
Fountain Hills
2000 Emp. Proj. 12493
2002 Emp. Proj. 9237
Paradise Valley
2000 Emp. Proj. 6075
2002 Emp. Proj. 6009
SRPMIC
2000 Emp. Proj. 7640
2002 Emp. Proj. 41239
Tolloson
2000 Emp. Proj. 19108
2002 Emp. Proj. 43686
Buckeye
2000 Emp. Proj. 98525
2002 Emp. Proj. 299213
Mesa
2000 Emp. Proj. 338485
2002 Emp. Proj. 352621
Tempe
2000 Emp. Proj. 214576
2002 Emp. Proj. 215461
Goodyear
2000 Emp. Proj. 70300
2002 Emp. Proj. 215772
Avondale
2000 Emp. Proj. 47713
2002 Emp. Proj. 73959
Guadalupe
2000 Emp. Proj. 4851
2002 Emp. Proj. 1892
Gilbert
2000 Emp. Proj. 91753
2002 Emp. Proj. 150030
Chandler
2000 Emp. Proj. 212038
2002 Emp. Proj. 162203
GRIC
2000 Emp. Proj. 32059
2002 Emp. Proj. 20261
Queen Creek
2000 Emp. Proj. 12205
2002 Emp. Proj. 42235
17
101
51
303
101
101
10
10
202
60
202
Legend
Freeway
Proposed Parkway/Highway
Major Arterials
Railroad
2040 Employment Projection in 2000
2040 Employment Projection in 2002
Source:
MAG Draft 1 and Draft 2 Socioeconomic Projections
0 1.25 2.5 5 7.5 10 Miles
N
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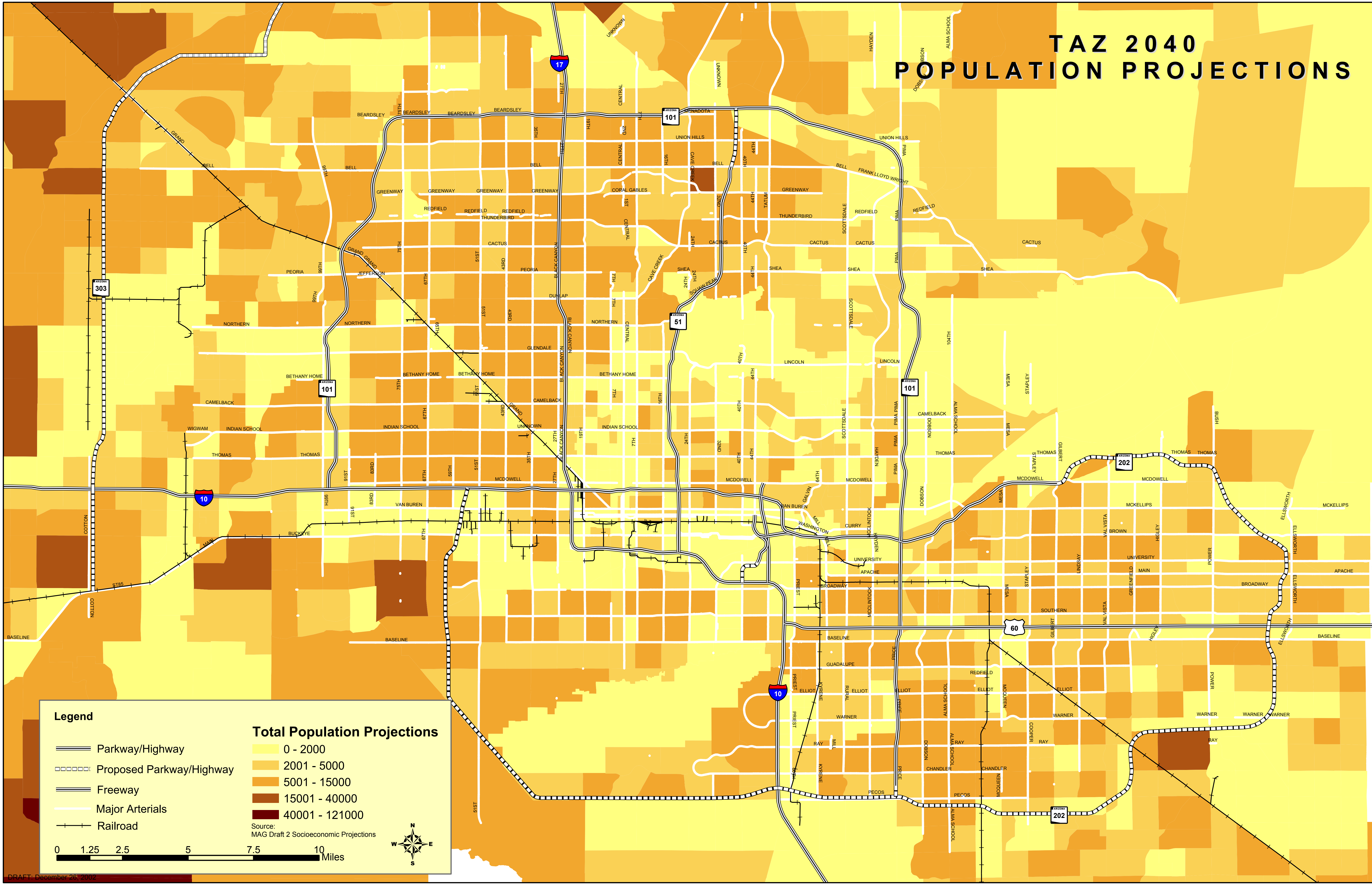
S
DRAFT: December 26, 2002


TAZ 2040
POPULATION PROJECTIONS
Legend
Parkway/Highway
Proposed Parkway/Highway
Freeway
Major Arterials
Railroad
Total Population Projections
0 - 2000
2001 - 5000
5001 - 15000
15001 - 40000
40001 - 121000
Source:
MAG Draft 2 Socioeconomic Projections
0 1.25 2.5 5 7.5 10 Miles
N
W
E
S
DRAFT: December 26, 2002

5.0.1 Refinement of Ridership and Cost Estimates

Four freight rail corridors were identified in the MAG region as potential commuter rail corridors:

- Burlington Northern Santa Fe (BNSF) – downtown Phoenix to Surprise *(potential extension to Wickenburg)*
- Union Pacific Mainline/Chandler – downtown Phoenix to Chandler
- Union Pacific Southeast – downtown Phoenix to Queen Creek
- Union Pacific Yuma – downtown Phoenix to Buckeye *(potential extension to Palo Verde Nuclear Generating Station)*

Three phases of service were developed for the implementation of commuter rail service in the MAG region. The objective of phased implementation is to spread the capital costs for implementing service over a period of years to allow for ridership growth. The characteristics of the three phases of service are:

- Phase 1: Start-up. This service involves limited peak-period service consisting of 3 trains inbound in the a.m. peak and 3 trains outbound in the p.m. peak. Span of service would likely be 6 hours (3 hours in a.m. peak, 3 hours in p.m. peak).
- Phase 2: Intermediate. This stage represents an increase in service to 6 trains inbound in the a.m. peak and 6 outbound in the p.m. peak. Counter flow service of one train per hour would be provided during morning and afternoon peaks. Off-peak service would consist of hourly service during the midday and evening. Span of service would be about 15 hours (6 a.m. to 9 p.m.).
- Phase 3: Full Operation. The final phase consists of 12 trains running inbound during the a.m. peak and outbound during p.m. peak with 15 minute headways. Counter flow peak period service would be provided every 30 minutes. Off-peak trains would run every 30 minutes. Span of service would be 18 hours (5 a.m. to 11 p.m.).

Based upon the results of the capital cost estimates and discussions with representatives from BSNF and UP, it was determined that only the Phase 1 and Phase 3 levels of service would be carried forward for further evaluation. Phase 1 service represents the minimum amount of service needed to be provided to operate a potential viable commuter rail service, with three trains operating during the peak commute. Phase 3 service would be the ultimate operation of commuter rail service which would provide residents of the MAG region with a true “turn up and go” service providing frequent and reliable service throughout the day during both peak and off-peak commute times. Phase 2 (Intermediate Service) is not being specifically evaluated in the portion of the report. Instead this service will be addressed during the discussion of phasing and implementation in Section 5.3.

Several of the data input assumptions for commuter rail service have been adjusted for Milestone 5 in light of the revised population projections and input from the Agency Working Group. Table 5.0-1 summarizes the refinements made to the commuter rail assumptions for Milestone 5.

Table 5.0-1 **Refined Commuter Rail Assumptions**

Data Input	MS 4 Assumption	MS 5 Revised Assumptions
Population Projection (2040)	Adopted population projections for the MAG region with a 2040 build out population of 6.4 million residents.	Updated population projections for the MAG region with a 2040 (Draft 2 Socioeconomic projections) build out population of 7.4 million residents. Phase 1 ridership estimates based upon 2020 Draft 2 population projections.
Stations	BNSF 6 stations.	BNSF 7 stations (additional Surprise station at Loop 303). All other corridors the same.
Station Catchment Area	3 mile primary catchment (secondary catchment to 5 miles).	3 miles primary, out to 10 miles for secondary catchment.
Costs	No change, however revisions were made between MS 4 drafts to refine some unit costs and the number of vehicles required.	Same as revised MS 4 but with more vehicles and parking spaces. Additional refinements to unit costs were also made.
Commute	No reverse commute.	Reverse commute assumed on all corridors.

There are several options in terms of operating windows, technology, and operating characteristics which could change the cost-effectiveness of commuter rail. In addition, the new population projections have resulted in revised ridership forecasts for the commuter rail corridors. A more refined view of commuter rail has therefore been undertaken in order to potentially identify strategies to reduce the capital and/or operating costs along one or more of the four possible corridors. The preliminary results of these strategies are presented below.

Revised Commuter Rail Ridership Forecasts

Commuter rail forecasts have been developed using a direct demand modeling (DDM) approach. A detailed description of the DDM methodology is contained in the Milestone 4 report. Additionally, the Recommended High Capacity Transit Network contained within this report will be modeled by MAG using a full four-stage modeling process. This modeling effort likely will occur during the next month and the results of the model run will be presented in a separate paper including an analysis and comparison of the modeling results and the sketch-planning modeling efforts.

The discussion in this report focuses on specific adjustments and refinements made to the model input factors and methodology, resulting from new population projections and comments from local agencies.

The DDM approach projects the number of weekday boarding passengers at proposed commuter rail stations using the population within station 'catchment' areas, factored according to the level of service (e.g. number of peak period trains, off peak service, time savings etc). Total corridor demand was simply the sum of boarding passengers for all stations within the corridor. In Milestone 4 certain stations were defined as 'destination' stations and no boarding passengers were assumed to board here for the outward leg of the trip.

Three refinements have subsequently been made to the methodology for the updated forecasts:

- Adjustment of catchment areas.
- Inclusion of 'destination' stations and 'counter-peak' (reverse) commute.
- Use of 2020 MAG Draft 2 population projections for Phase 1 ridership and costs.

Input assumptions have also been modified (e.g. station location) with the most significant being the inclusion of new population and employment projections.

Table 5.0-2 summarizes these refinements made to the ridership demand assumptions. On average these refinements resulted in a 10 percent ridership increase in each corridor using the population forecasts in Milestone 4.

Table 5.0-2 **Refined Ridership Demand Assumptions**

Corridor	Revised Assumptions
BNSF	• Additional station at Grand, Loop 303. • Reverse commute service.
UP Mainline/Chandler	• Reverse commute service. • Specific origin ridership demand generated at destination stations.
UP Southeast	• Reverse commute service. • Specific origin ridership demand generated at destination stations.
UP Yuma	• Reverse commute service.

The changes in population projections have been incorporated in the latest commuter rail ridership forecasts. Table 5.0-3 below summarizes the total ridership in each corridor. This figure is obtained by doubling the boarding total at each station to account for return trips.

Table 5.0-3 **Commuter Rail Total Ridership Forecasts and Comparison with Milestone 4**

Corridor	Total Boardings		Percent Change from Milestone 4	
	Initial (Phase 1) 2020	Ultimate (Phase 3) 2040	Initial (Phase 1) 2040	Ultimate (Phase 3) 2040
BNSF	4,862	16,145	70%	101%
UP Chandler/Mainline	1,372	4,561	15%	36%
UP Southeast	1,970	6,471	-19%	-5%
UP Yuma	2,710	12,034	17%	85%

There are several stations which have seen large increases in ridership resulting from refined population forecasts. Ridership forecasts from Buckeye in particular are much higher than those developed previously as they combine a substantial increase in local population (the additional Buckeye population is mainly within the Buckeye station catchment) with the addition of secondary catchment trips. As secondary trips are not modeled to be sensitive to train frequency, the additional trips from some stations are reduced from the Ultimate service when compared to Milestone 4. This is particularly the case where some areas were previously included within a primary catchment and have now been reassigned to a secondary catchment. Stations with somewhat reduced ridership compared to

Milestone 4 include Queen Creek and Williams Gateway. This illustrates the reduced population projections for these areas.

The action of adjusting Phase 1 ridership estimates to the Year 2020 does lower the projected ridership in each corridor, as a result of the lowered overall population levels in 2020 when compared to 2040. This also impacts the cost estimates for Phase 1 service by lowering the expected initial costs as a result of the need for fewer vehicles and station parking facilities. These refined ridership figures have no effect upon the cost of implementing and operating the Ultimate (Phase 3) level of service. Instead, this is a minor change to the estimated *initial* cost of implementing commuter rail service. This modification was made to present a more accurate forecast of ridership and costs based upon a more likely horizon year for implementing Phase 1 commuter rail service.

Despite these large changes, the comparative strength between corridors in terms of ridership remains the same as Milestone 4. BNSF continues to achieve the highest ridership, followed by UP Yuma. The UP Southeast and Mainline/Chandler corridors achieved the weakest ridership in Milestone 4, and the changes in population in this area have further exacerbated this. As stated in Milestone 4 however, these forecasts include no network interactions, and this shall next be incorporated through the use of the MAG four-stage model for the final report.

Revised Commuter Rail Capital and Operating Costs

Capital and operating cost estimates have been revised for each of the four commuter rail corridors for both the Start-Up and Full Service levels of service. Adjustments have been made to the cost estimates to include additional passenger vehicles and station parking to accommodate additional forecasted ridership on the UP Yuma and BNSF lines. Revisions have been made to the length of the UP Southeast and BNSF lines to more accurately reflect the true distances of these corridors. Finally, an additional station has been added to the BNSF line at Loop 303 and Grand Avenue to accommodate the population growth projected for the City of Surprise.

Commuter rail costs were developed using conventional locomotive hauled technology such as this operated by Sound Transit in Seattle.

<u>Commuter Rail Capital Costs</u>

The primary change to the capital cost estimates involves the need for additional vehicles and parking at stations along the UP Yuma and BNSF corridors to accommodate the larger number of forecasted riders. The same rail infrastructure requirements in respect to tracks and signaling assumed in Milestone 4 are assumed in these estimates. Minor modifications have also been made to the UP Southeast and UP Mainline/Chandler corridors to revise the number of vehicles required for Phase 3 service. Modified phasing in of Phase 3 service would allow for a lower vehicle requirement in both of these corridors. As noted above, Phase 1 capital costs are based upon 2020 ridership projections.

Table 5.0-4 compares the capital costs presented in Milestone 4 and revised capital costs for each corridor. The costs for the Startup and Full Service phases are both included in this table. Additional detail for the revised commuter rail capital costs is provided in Table 5.0-5. The specific revisions to these costs are detailed in Section 5.1.1.

Table 5.0-4

Commuter Rail Capital Cost Comparison

Commuter Rail Corridor	Previous (Milestone 4) Capital Costs ($ millions)	Revised Capital Costs ($ millions)	Change in Capital Cost (MS 4 to MS 5)
BNSF Phase 1	$289.39	$292.30	$2.91
BNSF Phase 3	$360.40	$445.63	$85.23
BNSF Total	$649.79	$737.93	$88.14
UP Mainline/Chandler Phase 1	$273.87	$269.93	-$3.94
UP Mainline/Chandler Phase 3	$265.41	$260.29	-$5.12
UP Mainline/Chandler Total	$539.29	$530.22	-$9.07
UP Southeast Phase 1	$295.88	$270.34	-$25.54
UP Southeast Phase 3	$348.66	$297.15	-$51.51
UP Southeast Total	$644.54	$567.50	-$77.04
UP Yuma Phase 1	$141.58	$143.25	$1.67
UP Yuma Phase 3	$268.10	$308.55	$40.45
UP Yuma Total	$409.68	$451.80	$42.12

Note: Phase 3 costs under Milestone 4 represent the costs of implementing both Phase 2 (Intermediate) and Phase 3 (Full Service) commuter rail operations.

Table 5.0-5 Revised Commuter Rail Capital Cost Summary

Item			BNSF Phase 1	BNSF Phase 3	UP Mainline/ Chandler Phase 1	UP Mainline/ Chandler Phase 3	UP Southeast Phase 1	UP Southeast Phase 3	UP Yuma Phase 1	UP Yuma Phase 3
Corridor Length (miles)			27.73	27.73	27.95	27.95	36.18	36.18	32.5	32.5
Subtotal-Civil			$12,072,304	$198,400	$23,106,160	$188,890	$24,829,520	$334,500	$1,250,000	$1,914,000
Subtotal-Utilities			$23,138,016	$3,273,600	$13,024,440	$3,116,685	$13,024,440	$903,150	$0	$1,742,400
Subtotal-Track			$33,332,994	$6,658,195	$28,200,799	$4,666,366	$19,695,628	$7,511,088	$0	$2,460,880
Subtotal-Stations			$30,382,000	$15,414,000	$31,280,000	$3,570,000	$31,518,000	$5,124,000	$24,066,000	$11,760,000
Subtotal-Controls & Signals			$0	$28,269,856	$15,785,584	$10,908,972	$15,585,584	$18,905,720	$0	$28,454,896
Subtotal Facilities			$2,620,000	$22,000,000	$2,800,000	$15,000,000	$3,620,000	$17,000,000	$3,090,000	$20,000,000
A. Construction Subtotal			**$101,545,314**	**$75,814,051**	**$114,196,983**	**$37,450,913**	**$108,273,172**	**$49,778,458**	**$28,406,000**	**$66,332,176**
Environmental Mitigation	Percent of A	2%	$2,030,906	$1,516,281	$2,283,940	$749,018	$2,165,463	$995,569	$568,120	$1,326,644
B. Construction Cost Subtotal			**$103,576,220**	**$77,330,332**	**$116,480,923**	**$38,199,931**	**$110,438,635**	**$50,774,027**	**$28,974,120**	**$67,658,820**
C. Right of Way Subtotal			**$10,802,875**	**$128,424,550**	**$6,969,600**	**$66,536,800**	**$7,715,325**	**$73,539,500**	**$10,637,350**	**$58,318,125**
D. Vehicles Subtotal			**$76,945,000**	**$85,450,000**	**$46,587,500**	**$70,050,000**	**$54,167,500**	**$73,305,019**	**$60,525,000**	**$78,600,000**
Cost Contingencies (Uncertainties, Changes)										
Design&Construction	Percent of B	25%	$25,894,055	$19,332,583	$29,120,231	$9,549,983	$27,609,659	$12,693,507	$7,243,530	$16,914,705
Right of Way	Percent of C	30%	$3,240,863	$38,527,365	$2,090,880	$19,961,040	$2,314,598	$22,061,850	$3,191,205	$17,495,438
Vehicle Cost	Percent of D	10%	$7,694,500	$8,545,000	$4,658,750	$7,005,000	$5,416,750	$7,330,502	$6,052,500	$7,860,000
Program Implementation (Agency Costs and Fees)										
Design&Construction	Percent of B	31%	$32,108,628	$23,972,403	$36,109,086	$11,841,979	$34,235,977	$15,739,948	$8,981,977	$20,974,234
Right of Way Purchase	Percent of C	15%	$1,620,431	$19,263,683	$1,045,440	$9,980,520	$1,157,299	$11,030,925	$1,595,603	$8,747,719
Vehicle Procurement	Percent of D	5%	$3,847,250	$4,272,500	$2,329,375	$3,502,500	$2,708,375	$3,665,251	$3,026,250	$3,930,000
E. Capital Cost Subtotal			**$265,729,823**	**$405,118,415**	**$245,391,784**	**$236,627,752**	**$245,764,118**	**$270,140,528**	**$130,227,535**	**$280,499,040**
Project Reserve	Percent of E	10%	$26,572,982	$40,511,842	$24,539,178	$23,662,775	$24,576,412	$27,014,053	$13,022,753	$28,049,904
F. Total Capital Cost			**$292,302,805**	**$445,630,257**	**$269,930,963**	**$260,290,528**	**$270,340,529**	**$297,154,581**	**$143,250,288**	**$308,548,944**
			Total all 3 Phases	**$737,933,062**	**Total all 3 Phases**	**$530,221,490**	**Total all 3 Phases**	**$567,495,110**	**Total all 3 Phases**	**$451,799,232**

Note: All costs are in 2001 dollars. More detailed information on costs can be found in Appendix A.

Commuter Rail Operating and Maintenance Costs

Operating and maintenance costs for commuter rail service were estimated using the same method as in Milestone 4. Year 2001 bus and commuter rail operating costs from four other commuter rail operators were used as a basis for estimating the likely annual cost of operating commuter rail service in the MAG region.

Operating costs in Phase 1 include the cost of lease access rights to the corridor, even in corridors where a second main track is constructed. In this case, the freight railroad operators still own the underlying right-of-way and would likely charge for commuter rail use of their property. In Phase 3, it is assumed that the commuter rail operator will purchase a portion of the right-of-way where a second main track exists, so lease costs are only included in single track portions of the corridors.

Adjustments have been made to the operating costs to reflect the different sized trains required on the routes to accommodate the new forecasted ridership. Table 5.0-6 presents operating and maintenance costs estimates from Milestone 4 along with the revised cost estimates.

Table 5.0-6 **Commuter Rail Operating Cost Comparison**

Commuter Rail Corridor	Previous (Milestone 4) Annual O&M Cost ($ millions)	Revised Annual O&M Cost ($ millions)	Change in O&M Cost (MS 4 to MS 5)
BNSF Phase 1	$3.45	$4.90	$1.45
BNSF Phase 3	$18.25	$22.55	$4.30
UP Mainline/Chandler Phase 1	$2.00	$1.85	-$0.15
UP Mainline/Chandler Phase 3	$14.05	$14.05	$0.00
UP Southeast Phase 1	$4.65	$3.05	-$1.60
UP Southeast Phase 3	$21.60	$16.1	-$5.50
UP Yuma Phase 1	$2.80	$3.60	$0.80
UP Yuma Phase 3	$19.95	$22.4	$2.45

Alternative Commuter Rail Operating Scenarios

Due to the results of Milestone 4 and the possible impediments to implementation caused by the large amount of capital infrastructure required to implement commuter rail in several of the freight railroad corridors, a series of alternatives were identified to explore more cost-effective ways of implementing commuter rail service in the MAG region.

These options include variations of ownership of the freight corridor, the utilization of operating windows, exploration into the use of diesel multiple unit trains, and modifications to the operating characteristics of the commuter rail service involving different corridor lengths and the number of stations.

Freight Track Ownership Options

Milestone 2 included a discussion of several models for rail right-of-way ownership. Two of these options were identified as realistic and potentially viable options for ownership arrangements on the two private freight railroads in the MAG region.

Cost estimates developed as part of Milestone 4 assumed a combination of the two models with the purchase of a portion of each freight railroad line in order to operate the Phase 3 service, while access rights are leased in Phase 1 and on certain lower demand portions of corridors in Phase 3. The revised cost estimates below explore the implications of using operating windows for commuter rail trains assigned to run during peak periods to reduce capital costs during the initial start-up of commuter rail service. Phase 1 costs are based upon the 2020 ridership levels noted above.

These alternative cost estimates have been prepared for three of the commuter rail corridors: BNSF, UP Mainline/Chandler, and UP Southeast. Each of these new estimates assumes the lease of track rights within specific operating windows during the am and pm peak periods. In all cases, these operating windows would require minimal or no freight rail service occurring. This would allow the commuter rail trains to operate at acceptable speeds and maintain scheduling. No estimate for the UP Yuma corridor is provided here because all phases of service implementation in this corridor assume the lease of track rights and no additional main track. This corridor experiences a much lower level of freight railroad traffic than the portion of the Union Pacific line east of Phoenix because of the closure of the corridor west of Palo Verde to Yuma. In effect, the UP Yuma corridor operates more like a branch line than a mainline. The reduced amount of traffic along this portion of the line allows for the implementation of commuter rail service with only the addition of a two mile siding for freight car switching activities.

According to BNSF, the establishment of operating windows in the BNSF corridor would require the relocation of the freight rail facilities near downtown Phoenix to a location north of El Mirage. The cost estimates produced below do not include the cost of this relocation since predicting the public cost of this relocation is not possible until extensive negotiations with BNSF have occurred.

These alternatives involve the lease of rights during the Phase 1 start-up service. This option assumes the construction of a second main track, implementation of Centralized Traffic Control (CTC) signals, and the purchase of the underlying right-of-way for the Phase 3 level of service where leasing does not occur. The benefit of this proposal is delaying the cost of implementing the second main track over a longer period of time, allowing for the identification of sufficient funding and growth in ridership. The capital and operating costs for implementing this option are summarized in Table 5.0-7. Operating costs are the same because the lease of rights for using the second main track was assumed in the original cost estimate.

Table 5.0-7 **Commuter Rail Track Lease Options**

Corridor	New Capital Cost ($ millions)	New Annual Operating Cost ($ millions)	Cost Effectiveness with Lease	Standard Investment Cost Effectiveness
Option 1 (Lease only in Phase 1)				
BNSF	$174.05	$4.90	$25.81	$38.78
UP Mainline/Chandler	$178.81	$1.85	$78.50	$113.92
UP Southeast	$178.69	$3.05	$58.70	$83.51

Note: These costs do not assume the cost for relocating the BNSF freight yard. The Standard Investment is considered to be a second main track consistent with the cost estimate contained in Table 5.0-5 above.

Another alternative for implementing service in the BNSF or UP corridors is the purchase of the entire freight rail right-of-way, with the freight rail operator(s) then leasing rights to use the track owned by MAG or another public agency in the MAG region. This alternative would likely increase the initial capital cost of the service due to the cost of purchasing the rail right-of-way. Long-term operating costs would be reduced since the commuter rail agency would receive an annual lease payment from the freight operator for the use of the tracks. However, this long-term cost savings would not likely off-set the initial capital cost of purchasing the corridor. The benefit of this arrangement would be that the commuter rail operating agency would be in control of dispatching and scheduling.

These purchases can be used as a guide for the estimated cost of purchasing freight railroad rights-of-way. However, the purchase of freight railroad rights-of-way in the MAG region may result in dramatically different costs. Freight railroad companies negotiate purchase prices on a case-by-case basis and the experiences of public agencies in other metropolitan regions cannot be directly correlated to a likely scenario in the MAG region. Given this fact, it is difficult to develop an accurate cost estimate for this scenario.

Diesel Multiple Unit Technology

All of the recent "New Starts" commuter rail operations which have become operational in the last 10 years share a similar vehicle technology consisting of diesel locomotive-hauled trains operated in a push-pull configuration. West Coast commuter rail providers not only share train technologies, but also manufacturers. The one commuter rail agency to deviate from this technology was the Trinity Railway Express in Dallas, Texas. This agency operated Budd Rail Diesel Cars (RDC) for a short period during the initial implementation of commuter service between Dallas and its suburb of Irving. The RDCs have since been replaced by traditional locomotive-hauled trains.

Recently, a new type of commuter rail technology has been implemented in North America. The Diesel Multiple Unit (DMU) rail vehicle has been successfully used in Europe for many years, but had not appeared in North America due to the inability of existing designs to meet Federal Railroad Administration (FRA) safety regulations. The Ottawa O-Train utilizes Bombardier Talent DMUs with an operating waiver from the Canadian Government.

Another manufacturer, Colorado Rail Car, has announced that they have designed a DMU vehicle which meets FRA safety regulations. Given the long-term nature of this study, it is reasonable to explore a scenario where both the Talent and the Colorado Rail Car DMUs are fully certified by the FRA for use in mixed freight and passenger corridors. Research into the current Federal Transit Administration's New Starts process has revealed that two public agencies have submitted DMU-based commuter rail projects to the Federal funding process. These DMU systems are proposed in Raleigh-Durham, North Carolina and Tampa, Florida. Both projects are in the Preliminary Engineering phase.

DMUs possess several operational advantages over conventional locomotive trains. The DMU vehicles are usually less expensive than a comparable locomotive-hauled unit on a per passenger basis, are more fuel-efficient, and are capable of quicker acceleration and deceleration rates thanks to lower overall weight. Disadvantages include the need for additional vehicles if single-level vehicles are selected, possible increases in maintenance costs due to the relative uniqueness of the technology in North America, and possible early replacement of vehicles and limited life cycle. Several European train operators have been replacing Talent vehicles after 10 to 15 years of revenue service, while standard locomotive-hauled coaches will operate for approximately 30 years.

Above are examples of the three commuter vehicle technologies. The Colorado Rail Car bi-level DMU is on top. The central photo is the Bombardier Talent in Ottawa. The bottom picture is the conventional locomotive train operated by Dallas Trinity Railway Express

Diesel Multiple Unit Costs

Capital and operating costs have been developed for the implementation of commuter rail service using DMU trains. Table 5.0-8 summarizes the capital cost of implementing DMU service with each of the two vehicles described above along with a comparison to the conventional locomotive cost estimates. Table 5.0-8 provides a summary and comparison of operating costs for the three vehicle types.

Table 5.0-8 **DMU Capital Cost Table**

Corridor	Colorado Rail Car DMU ($ millions)	Bombardier Talent DMU ($ millions)	Conventional Locomotive ($ millions)
BNSF Phase 1	$302.54	$299.76	$292.30
BNSF Phase 3	$426.15	$430.32	$445.63
BNSF Total	**$728.69**	**$730.08**	**$737.93**
UP Mainline/Chandler Phase 1	$253.04	$251.78	$269.93
UP Mainline/Chandler Phase 3	$229.05	$203.88	$260.29
UP Mainline/Chandler Total	**$482.10**	**$455.66**	**$530.22**
UP Southeast Phase 1	$257.58	$250.62	$270.34
UP Southeast Phase 3	$259.58	$266.54	$297.15
UP Southeast Total	**$517.16**	**$517.16**	**$567.50**
UP Yuma Phase 1	$129.72	$129.78	$143.25
UP Yuma Phase 3	$302.86	$319.56	$308.55
UP Yuma Total	**$432.58**	**$449.27**	**$451.80**

Note: Phase 1 costs for all three technologies results from 2020 ridership projections.

Operating and Maintenance Cost Assumptions

Operating costs for the Colorado Rail Car DMU were estimated using the operating cost estimates developed for the Sonoma-Marin Commuter Rail Study (SMART). The SMART study involves a 68 mile corridor with initial service of 4 trains per day (3 peak and 1 off-peak) between Sonoma and Marin counties in the San Francisco Bay Area of Northern California.

Operating costs for commuter rail service with the Bombardier Talent DMU were developed using the results of an evaluation report produced in December 2002 by OC Transpo for the City of Ottawa. The annual operating cost for this service was then converted to US Dollars using a $0.65 conversion rate. Table 5.0-9 summarizes the estimated annual revenue mile and revenue hour costs used for the three commuter rail vehicles to estimate annual operating costs. Operating costs are then summarized for the three technologies in Table 5.0-10. Cost effectiveness results for the three commuter rail vehicle technologies are compared in Table 5.1-11. This cost effectiveness figure is for the Phase 3 level of service.

Table 5.0-9 **DMU Annual Revenue Mile and Hour Costs**

Vehicle	Annual Cost per Revenue Service Mile	Annual Cost per Revenue Service Hour
Conventional Locomotive-Hauled	$16.81	$487.64
Colorado Rail Car DMU	$14.32	$395.11
Bombardier Talent DMU	$10.56	$209.98

Table 5.0-10 **DMU Operating and Maintenance Cost Comparison**

Corridor	Colorado Rail Car DMU ($ millions)	Bombardier Talent DMU ($ millions)	Conventional Locomotive ($ millions)
BNSF Phase 1	$3.45	$3.94	$4.90
BNSF Phase 3	$21.15	$20.60	$22.55
UP Mainline/Chandler Phase 1	$1.55	$1.49	$1.85
UP Mainline/Chandler Phase 3	$12.71	$8.46	$14.25
UP Southeast Phase 1	$2.64	$2.31	$3.05
UP Southeast Phase 3	$14.54	$14.17	$17.50
UP Yuma Phase 1	$2.42	$2.59	$3.60
UP Yuma Phase 3	$20.69	$19.78	$22.40

Table 5.0-11 **DMU Cost Effectiveness Comparison**

Corridor	Colorado Rail Car DMU Cost Effectiveness	Bombardier Talent DMU Cost Effectiveness	Conventional Locomotive Cost Effectiveness
BNSF Phase 3	$16.40	$16.31	$16.84
UP Mainline/Chandler Phase 3	$37.48	$32.82	$41.41
UP Southeast Phase 3	$30.07	$29.87	$33.83
UP Yuma Phase 3	$15.32	$15.43	$16.22

As shown in the two tables above, DMU technology does offer a potentially cost-effective alternative to conventional locomotive-hauled commuter trains. The relative uniqueness of the DMU technology in North America may create some procurement and maintenance issues. However, as the technology becomes more prevalent, these additional risks and costs will be minimized. Given the long-term horizon of this study it remains prudent to retain DMU technology as a possible option for providing commuter rail service in the MAG region. The selection of a specific technology for commuter rail in a selected freight corridor in the MAG region would require a detailed Major Investment Study (MIS).

LRT/Dedicated BRT Revised Ridership and Cost Estimates

Modifications have been made to several corridors in terms of alignment and limits as a result of comments from local agencies and consolidations of parallel or overlapping corridors. Additionally, a new corridor, Central Avenue South, has been added to the analysis. These revisions to the proposed LRT/Dedicated BRT network are explained in detail in Section 5.2.2. Table 5.0-12 provides a summary of the new corridor limits and alignments. Each alignment in the table represents a single centerline street or freeway selected for the development of cost and ridership estimates. The actual corridors are five miles in width and a final alignment could include other streets parallel to the alignments identified in the table.

Table 5.0-12 **LRT/Dedicated BRT Corridor Refinements**

Corridor	Previous Limits	Revised Limits	Reason for Alignment Changes
59th Avenue	51st Ave/Baseline Rd to 59th Ave/Bell Rd	Same	n/a
Bell Road	Loop 303 to Scottsdale Road	Same	n/a
Camelback Road	Loop 101 West Valley to Scottsdale Road	Central Avenue to Scottsdale Road	Western portion consolidated with Glendale Avenue
Central Avenue South	n/a	Baseline Road to CP/EV LRT alignment	New corridor
Chandler Boulevard	Ray Road to Power Road	Same	n/a
Glendale Avenue (formerly Northern Avenue)	Northern/19th Avenue to Northern/Loop 101 West	Glendale/I-17 to Glendale/Loop 101 W	Consolidated with Camelback corridor, serve Glendale sports facility at Loop 101
I-10 West	Central Ave/Van Buren to I-10/Loop 101 West	Same	n/a
Main Street	CP/EV Terminus to Power Road	Same	n/a

Corridor	Previous Limits	Revised Limits	Reason for Alignment Changes
Metrocenter/I-17	19th/Bethany Home to Metrocenter Mall (Peoria Ave/I-17)	19th/Bethany Home to Bell/I-17	Matches City of Phoenix Long Range LRT plan
Power Road	Power/Williams Field to McDowell/Higley	Same	n/a
Scottsdale Road/Rural Road	Bell Rd/Scottsdale Rd to Price Rd/Queen Creek Rd	Bell Rd/Scottsdale Rd to UP Tempe Branch southern terminus	Southern portion consolidated with UP Tempe Branch
SR-51	Central Ave/Camelback Rd to Tatum/Loop 101	Central Ave/Indian School to Tatum/Loop 101	Match alignment to City of Phoenix Long Range LRT plan
Union Pacific Chandler Branch	Price Rd/Queen Creek Rd to UP Mainline	Price Rd/Queen Creek Rd to Main St/Mesa Rd	Connect to Main Street Corridor
Union Pacific Tempe Branch	UP Mainline (Tempe Junction) to southern terminus (56th St/I-10)	None	Consolidated with Scottsdale/Rural corridor

Ridership estimates produced for the LRT/Dedicated BRT corridors in Milestone 4 were based upon the previous population projections and assumed a standardized station spacing of ½ mile along the entire route. These estimates have been revised for this report by applying the sketch planning model to the new population projections. Station locations were also revised to be located on average about one mile apart. This station spacing is more consistent with other West Coast LRT systems and the majority of Central Phoenix/East Valley (CP/EV) LRT system.

Cost estimates for implementing LRT in the proposed corridors were updated with new unit values derived from other West Coast LRT projects, including the CP/EV project. These revisions to the unit values have had a minimal effect upon the overall estimates in each corridor, usually less than $1-2 million per mile. BRT costs were revised to account for the paving of the BRT guideway with concrete instead of asphalt pavement.

LRT vehicles can take many forms including this one in Norway

Updated forecasts are shown below in Table 5.0-13. Note that five corridors have also been evaluated as extensions of the proposed Central Phoenix and East Valley (CP/EV) LRT line to give some indication of the benefit of through-running service. These extension figures were not used in any of the evaluation processed contained later in the report. They are presented solely for reference. Where possible, the change from Milestone 4 is shown, but for a number of corridors the changes to the network are too large for comparison. In the case of Central Avenue, this corridor was not included in the Milestone 4 evaluation.

An additional corridor included in the ridership table is a hybrid

Express/Dedicated BRT service on Grand Avenue. This service was analyzed at the request of several cities in the Grand Avenue corridor as an alternative technology if commuter rail was deemed infeasible. The BRT service proposed involves buses operating in mixed-flow traffic for a majority of the route. Exclusive queue jumping lanes are proposed at all signalized intersections, along with signal priority systems. This type of operation is not as efficient as a full Dedicated BRT service, but is a substantial upgrade above standard bus service.

Table 5.0-13

Updated LRT/BRT Ridership Projections

Corridor	Length	Estimated Average Daily boardings	Boardings per mile	Percent Change from Milestone 4
59th Avenue	19	12,829	675	-36%
Bell Road	29	19,750	691	-33%
Camelback	9	8,126	945	-21%
Central Avenue South	5	5,749	1,150	n/a
Chandler Boulevard	17	12,226	741	1%
Glendale	10	7,226	737	n/a
I-10 West	11	13,765	1,251	32%
Main Street	10	9,697	1,010	-6%
Metrocenter/I-17	9	8,848	1,005	n/a
Power Road	13	8,653	666	-30%
Scottsdale Road/Tempe Branch	26	20,672	811	-15%
SR-51	17	12,334	713	23%
UP Chandler Branch	13	12,534	995	-29%
As extensions				
Metrocenter/I-17	9	14,178	1,611	-4%
Central Avenue South	5	6,316	1,263	n/a
Glendale Avenue	10	8,753	893	n/a
SR-51	17	18,046	1,043	n/a
Main Street	10	16,246	1,692	n/a
Alternative scenarios				
Grand Avenue	26	11,770	456	n/a

Notes: Metrocenter was only forecasted as an extension in Milestone 4. For more detail on alignment changes see Table 5.0-12.

As suggested by the changes in population and station-spacing, most of the LRT projections have declined from those originally developed for Milestone 4. The doubling of station intervals reduces ridership forecast by up to 20 percent, with the remainder of the ridership difference due to corridor definition changes and population and employment projection changes. 59th Avenue, Bell Road, Power Road and the UP Chandler Branch are reduced the most, mainly due to changes in the distribution of population. I-10 West and SR-51 increased compared to Milestone 4 reflecting the general increase in development in the west and in the north.

Revised LRT Cost Estimates

The capital and operating and maintenance costs have been revised for each of the 13 potential LRT corridors to reflect updates to the unit costs and changes to several of the alignments in each corridor.

Capital Cost Estimates

Table 5.0-14 provides a comparison between the capital costs in Milestone 4 and the revised capital costs presented in this report. Table 5.0-15 summarizes the capital cost estimates for each of the potential LRT corridors.

Table 5.0-14 **LRT Cost Comparison Table**

LRT Corridor	Previous (Milestone 4) Capital Costs ($ millions)	Revised Capital Costs ($ millions)	Change in Capital Costs (MS 4 to MS 5)
59th Avenue	$767.58	$727.81	-$39.77
Bell Road	$1,137.65	$1,102.24	-$35.41
Camelback Road	$881.03	$349.36	-$531.67
Central Avenue South	n/a	$228.03	n/a
Chandler Boulevard	$651.89	$683.75	$31.86
Glendale Avenue	$248.87	$429.22	$180.35
I-10 West	$388.58	$399.34	$10.76
Main Street	$360.49	$373.63	$13.14
Metrocenter/I-17	$220.04	$337.65	$117.61
Power Road	$498.20	$465.10	-$33.1
Scottsdale Road	$1,244.02	$1,010.84	-$233.18
SR-51	$837.67	$823.28	-$14.39
Union Pacific Chandler Branch	$495.97	$460.86	-$35.11

Notes: The Glendale Avenue MS 4 cost is for Northern Avenue east of Grand Ave. The UP Tempe Corridor was combined with the Scottsdale Corridor, so the capital costs for UP Tempe are not presented here.

Table 5.0-15 Light Rail Capital Cost Summary

Item	59th Avenue	Bell Road	Camelback Road	Central Avenue South	Chandler Boulevard	Glendale Avenue	I-10 West	Main Street	Metrocenter	Power Road	Scottsdale Road	SR-51	Union Pacific Chandler Branch
Corridor Length (miles)	18.99	28.55	8.63	4.93	16.45	9.75	11.05	9.64	8.57	13.04	25.55	17.34	12.60
Subtotal-Civil Site Mods	$30,623,475	$46,068,200	$14,460,650	$8,240,360	$24,023,900	$14,968,000	$16,671,100	$16,611,225	$12,400,000	$21,521,600	$35,044,000	$19,239,625	$6,649,000
Subtotal-Guideway	$59,824,711	$57,522,832	$18,699,834	$25,921,714	$76,783,124	$40,108,440	$15,656,856	$9,438,841	$17,705,140	$22,498,116	$80,841,180	$132,328,105	$16,287,072
Subtotal-Utilities	$42,622,825	$64,076,400	$19,365,550	$11,062,920	$36,922,300	$21,879,000	$24,796,200	$21,632,075	$19,635,000	$29,267,200	$57,222,000	$38,910,875	$28,274,400
Subtotal-Track	$37,720,905	$54,663,360	$16,733,070	$10,466,088	$33,289,020	$19,629,000	$20,913,980	$18,205,155	$16,426,800	$24,815,880	$50,311,200	$36,543,675	$25,688,160
Subtotal-Stations	$41,525,000	$61,775,000	$20,575,000	$9,375,000	$42,375,000	$24,950,000	$21,225,000	$19,350,000	$18,100,000	$25,975,000	$48,675,000	$44,275,000	$25,575,000
Subtotal-Systems & Electrical	$91,047,948	$138,079,226	$42,032,162	$23,736,523	$79,375,582	$47,058,010	$53,290,308	$46,918,268	$40,874,450	$62,750,448	$121,622,380	$81,609,960	$61,397,896
Subtotal - Facilities	$7,500,000	$12,500,000	$5,500,000	$4,500,000	$7,500,000	$6,250,000	$5,500,000	$7,000,000	$3,500,000	$5,500,000	$12,000,000	$9,000,000	$7,250,000
A. Construction Subtotal	**$310,864,864**	**$434,685,018**	**$137,366,266**	**$93,302,604**	**$300,268,926**	**$174,842,450**	**$158,053,444**	**$139,155,564**	**$128,641,390**	**$192,328,244**	**$405,715,760**	**$361,907,240**	**$171,121,528**
Environmental Mitigation	$6,217,297	$8,693,700	$2,747,325	$1,866,052	$6,005,379	$3,496,849	$3,161,069	$2,783,111	$2,572,828	$3,846,565	$8,114,315	$7,238,145	$3,422,431
B. Construction Cost Subtotal	**$317,082,161**	**$443,378,718**	**$140,113,591**	**$95,168,656**	**$306,274,305**	**$178,339,299**	**$161,214,513**	**$141,938,675**	**$131,214,218**	**$196,174,809**	**$413,830,075**	**$369,145,385**	**$174,543,959**
C. Right of Way Subtotal	**$62,051,975**	**$101,652,400**	**$30,108,250**	**$13,527,480**	**$51,746,100**	**$30,999,000**	**$25,237,200**	**$35,506,425**	**$32,274,100**	**$46,816,900**	**$84,524,000**	**$47,870,025**	**$49,176,700**
D. Vehicles Subtotal	**$66,975,000**	**$141,712,500**	**$48,141,750**	**$34,109,250**	**$59,801,250**	**$58,293,750**	**$65,175,000**	**$58,044,000**	**$48,225,000**	**$42,525,000**	**$131,137,500**	**$89,701,500**	**$65,535,000**
Cost Contingencies (Uncertainties, Changes)													
Design&Construction	$79,270,540	$110,844,680	$35,028,398	$23,792,164	$76,568,576	$44,584,825	$40,303,628	$35,484,669	$32,803,554	$49,043,702	$103,457,519	$92,286,346	$43,635,990
Right of Way	$18,615,593	$30,495,720	$9,032,475	$4,058,244	$15,523,830	$9,299,700	$7,571,160	$10,651,928	$9,682,230	$14,045,070	$25,357,200	$14,361,008	$14,753,010
Vehicle Cost	$6,697,500	$14,171,250	$4,814,175	$3,410,925	$5,980,125	$5,829,375	$6,517,500	$5,804,400	$4,822,500	$4,252,500	$13,113,750	$8,970,150	$6,553,500
Program Implementation (Agency Costs and Fees)													
Design&Construction	$98,295,470	$137,447,403	$43,435,213	$29,502,284	$94,945,034	$55,285,183	$49,976,499	$44,000,989	$40,676,408	$60,814,191	$128,287,323	$114,435,069	$54,108,627
Right of Way Purchase	$9,307,796	$15,247,860	$4,516,238	$2,029,122	$7,761,915	$4,649,850	$3,785,580	$5,325,964	$4,841,115	$7,022,535	$12,678,600	$7,180,504	$7,376,505
Vehicle Procurement	$3,348,750	$7,085,625	$2,407,088	$1,705,463	$2,990,063	$2,914,688	$3,258,750	$2,902,200	$2,411,250	$2,126,250	$6,556,875	$4,485,075	$3,276,750
E. Capital Cost Subtotal	**$661,644,785**	**$1,002,036,156**	**$317,597,177**	**$207,303,588**	**$621,591,198**	**$390,195,669**	**$363,039,830**	**$339,659,250**	**$306,950,375**	**$422,820,957**	**$918,942,842**	**$748,435,062**	**$418,960,040**
Project Reserve	$66,164,479	$100,203,616	$31,759,718	$20,730,359	$62,159,120	$39,019,567	$36,303,983	$33,965,925	$30,695,037	$42,282,096	$91,894,284	$74,843,506	$41,896,004
F. Total Capital Cost	**$727,809,264**	**$1,102,239,771**	**$349,356,895**	**$228,033,946**	**$683,750,317**	**$429,215,236**	**$399,343,813**	**$373,625,175**	**$337,645,412**	**$465,103,053**	**$1,010,837,127**	**$823,278,568**	**$460,856,044**

Note: All costs are in 2001 Dollars. Detailed cost information can be found in Appendix B.

LRT Operating and Maintenance Cost Estimates

No changes were made the assumptions for calculating the annual operating and maintenance costs for the LRT corridors. The changes to these cost estimates result from the proposed changes to the recommended alignments for selected corridors and revisions to the number of stations on each alignment. Modifications to the assumed headways were made to two corridors, Power Road and I-10 West. Both corridors are now assumed to provide more frequent service to accommodate projected ridership demand. Table 5.0-16 summarizes the headways assumed in each corridor.

Table 5.0-16 **Proposed LRT Headways**

LRT Corridor	Assumed Peak Period Headway (minutes)
59th Avenue	15
Bell Road	10
Camelback Road	10
Central Avenue South	10
Chandler Boulevard	15
Glendale Avenue	10
I-10 West	10
Main Street	10
Metrocenter/I-17	10
Power Road	15
Scottsdale Road	10
SR-51	10
Union Pacific Chandler Branch	10

Table 5.0-17 summarizes the annual operating and maintenance costs for the 12 potential LRT corridors. Costs are in Year 2001 dollars. Estimated operating and maintenance costs for these corridors in Milestone 4 are presented here for reference. Detailed operating and maintenance cost estimates can be found in Appendix B.

Table 5.0-17 **Light Rail Operating and Maintenance Costs**

LRT Corridor	Previous (Milestone 4) Annual O&M Cost ($ millions)	Revised Annual O&M Cost ($ millions)	Change in O&M Cost (MS 4 to MS 5)
59th Avenue	$11.35	$11.29	-$0.06
Bell Road	$22.58	$22.55	-$0.03
Camelback Road	$17.12	$7.63	-$9.49
Central Avenue South	n/a	$4.83	n/a
Chandler Boulevard	$9.79	$9.74	-$0.05
Glendale Avenue	$6.13	$8.96	$2.83
I-10 West	$6.79	$10.29	$3.50
Main Street	$8.96	$8.96	$0.00
Metrocenter/I-17	$4.93	$7.61	$2.68
Power Road	$7.22	$8.26	$1.04
Scottsdale Road	$22.58	$20.95	-$1.63
SR-51	$14.16	$14.34	$0.18
Union Pacific Chandler Branch	$10.44	$10.44	$0.00

Note: The Glendale Avenue costs have been compared to the Northern Avenue east of Grand Ave. costs from Milestone 4.

<u>Revised Dedicated BRT Cost Estimates</u>

Revisions have been made to the potential Dedicated BRT corridors to reflect the consolidation of selected corridors, revised alignments, and modifications to unit cost values used the capital cost estimates. Capital and operating and maintenance cost estimates have been produced for nine potential Dedicated BRT corridors. The three corridors which are not presented here, Metrocenter/I-17, Glendale Avenue, and I-10 West are committed to being implemented as LRT corridors in the MAG region as a result of either ballot measures or local agency implementation plans.

The Civis bus is a new form of Bus Rapid Transit vehicle that is slated for implementation in Las Vegas.

The cost estimates below include a scenario for a hybrid Express/Dedicated BRT service along Grand Avenue. This service was analyzed at the request of several cities in the Grand Avenue corridor as an alternative technology in the event that commuter rail was not feasible. As noted above, the buses in this corridor will not operate in a fully exclusive lane. Instead, travel times and operations will be enhanced by the presence of queue jumping lanes at signalized intersections.

Dedicated BRT Corridor Capital Cost Estimates

A major revision to the capital cost estimates for the Dedicated BRT corridors involves the assumption that the BRT guideway will be paved with concrete rather than asphalt as assumed in Milestone 4. This modification was made based upon the results of BRT implementation in other cities in North America and Agency Working Group input.

Table 5.0-18 provides a comparison between the capital costs in Milestone 4 and the revised capital costs presented in this report. Table 5.0-19 summarizes the revised capital costs for the nine potential Dedicated BRT corridors. All costs are presented in Year 2001 dollars.

Table 5.0-18

BRT Cost Comparison Table

LRT Corridor	Previous (Milestone 4) Capital Costs ($ millions)	Revised Capital Costs ($ millions)	Change on Capital Cost (MS 4 to MS 5)
59th Avenue	$288.67	$359.08	$70.41
Bell Road	$408.93	$539.11	$130.18
Camelback Road	$311.29	$165.65	-$145.64
Chandler Boulevard	$242.75	$306.02	$63.27
Main Street	$142.64	$184.71	$42.07
Power Road	$189.78	$236.83	$47.05
Scottsdale Road	$449.24	$465.96	$16.72
SR-51	$183.45	$254.67	$71.22
Union Pacific Chandler Branch	$204.82	$225.92	$21.10
Grand Avenue	n/a	$232.48	n/a

Notes: The Milestone 4 costs presented for SR-51 are the Glendale Ave/Cactus Ave costs produced in Milestone 4. No Dedicated BRT costs were produced in Milestone 4 for the SR-51 corridor.

Table 5.0-19 Bus Rapid Transit Capital Cost Summary

Item	59th Avenue	Bell Road	Camelback Road	Chandler Boulevard	Main	Power Road	Scottsdale Road	SR-51	Union Pacific Chandler Branch	Grand Avenue
Corridor Length (miles)	18.99	28.55	20.88	16.45	9.64	13.04	28.10	17.34	11.13	25.80
Subtotal-Civil/Roadway	$42,424,191	$60,883,898	$19,011,231	$35,588,540	$21,004,746	$27,775,902	$49,293,376	$24,536,921	$18,338,604	$18,696,143
Subtotal-Utilities	$35,101,150	$52,769,150	$15,948,100	$30,406,600	$17,814,650	$24,102,400	$47,124,000	$21,418,250	$23,284,800	$19,950,000
Subtotal-Stations	$30,827,500	$47,052,500	$14,602,500	$27,582,500	$16,225,000	$21,092,500	$40,562,500	$27,582,500	$21,092,500	$21,092,500
Subtotal-Systems & Electrical	$17,625,798	$26,477,026	$8,213,222	$15,258,170	$9,080,986	$11,742,909	$23,428,500	$13,293,236	$11,756,000	$18,031,500
Subtotal Facilities	$6,600,000	$7,950,000	$3,150,000	$3,900,000	$3,450,000	$2,700,000	$7,200,000	$5,250,000	$4,050,000	$9,650,000
A. Construction Subtotal	**$132,578,639**	**$195,132,573**	**$60,925,053**	**$112,735,811**	**$67,575,382**	**$87,413,711**	**$167,608,376**	**$92,080,907**	**$78,521,904**	**$87,420,143**
Environmental Mitigation	$2,651,573	$3,902,651	$1,218,501	$2,254,716	$1,351,508	$1,748,274	$3,352,168	$1,841,618	$1,570,438	$1,748,403
B. Construction Cost Subtotal	**$135,230,212**	**$199,035,225**	**$62,143,554**	**$114,990,527**	**$68,926,890**	**$89,161,985**	**$170,960,544**	**$93,922,525**	**$80,092,342**	**$89,168,545**
C. Right of Way Subtotal	**$68,123,975**	**$106,206,975**	**$31,626,250**	**$60,854,100**	**$35,506,425**	**$48,334,900**	**$92,470,500**	**$47,870,025**	**$47,796,700**	**$33,175,600**
D. Vehicles Subtotal	**$14,520,000**	**$22,264,000**	**$6,776,000**	**$9,196,000**	**$7,744,000**	**$5,324,000**	**$19,844,000**	**$13,552,000**	**$9,680,000**	**$20,988,000**
Cost Contingencies (Uncertainties, Changes)										
Design&Construction	$33,807,553	$49,758,806	$15,535,889	$28,747,632	$17,231,722	$22,290,496	$42,740,136	$23,480,631	$20,023,086	$22,292,136
Right of Way	$20,437,193	$31,862,093	$9,487,875	$18,256,230	$10,651,928	$14,500,470	$27,741,150	$14,361,008	$14,339,010	$9,952,680
Vehicle Cost	$1,452,000	$2,226,400	$677,600	$919,600	$774,400	$532,400	$1,984,400	$1,355,200	$968,000	$2,098,800
Program Implementation (Agency Costs and Fees)										
Design&Construction	$41,921,366	$61,700,920	$19,264,502	$35,647,063	$21,367,336	$27,640,215	$52,997,769	$29,115,983	$24,828,626	$27,642,249
Right of Way Purchase	$10,218,596	$15,931,046	$4,743,938	$9,128,115	$5,325,964	$7,250,235	$13,870,575	$7,180,504	$7,169,505	$4,976,340
Vehicle Procurement	$726,000	$1,113,200	$338,800	$459,800	$387,200	$266,200	$992,200	$677,600	$484,000	$1,049,400
E. Capital Cost Subtotal	**$326,436,894**	**$490,098,664**	**$150,594,407**	**$278,199,067**	**$167,915,864**	**$215,300,901**	**$423,601,274**	**$231,515,475**	**$205,381,269**	**$211,343,751**
Project Reserve	$32,643,689	$49,009,866	$15,059,441	$27,819,907	$16,791,586	$21,530,090	$42,360,127	$23,151,547	$20,538,127	$21,134,375
F. Total Capital Cost	**$359,080,584**	**$539,108,531**	**$165,653,848**	**$306,018,974**	**$184,707,451**	**$236,830,991**	**$465,961,401**	**$254,667,022**	**$225,919,396**	**$232,478,126**

Note: All costs are in 2001 Dollars. Detailed cost information can be found in Appendix C.

Dedicated BRT Operating and Maintenance Costs

No changes were made the assumptions for calculating the annual operating and maintenance costs for the Dedicated BRT corridors. Changes to these cost estimates result from the proposed changes to the recommended alignments for selected corridors and revisions to the number of stations on each alignment. No changes were made to the assumed headways. Table 5.0-21 summarizes the annual operating and maintenance costs for the nine potential BRT corridors. Costs are in Year 2001 dollars. Estimated operating and maintenance costs for these corridors in Milestone 4 are presented here for reference. Detailed operating and maintenance cost estimates can be found in Appendix B. Table 5.0-20 summarizes the peak period headways assumed for the Dedicated BRT corridors.

Table 5.0-20 **Proposed Dedicated BRT Headways**

Dedicated BRT Corridor	Assumed Peak Period Headway (minutes)
59th Avenue	5
Bell Road	5
Camelback Road	5
Chandler Boulevard	7
Main Street	5
Power Road	10
Scottsdale Road	5
SR-51	5
Union Pacific Chandler Branch	5
Grand Avenue	5

Table 5.0-21 **Operating and Maintenance Costs**

Dedicated BRT Corridor	Previous (Milestone 4) Annual O&M Cost ($ millions)	Revised Annual O&M Cost ($ millions)	Change in O&M Cost (MS 4 to MS 5)
59th Avenue	$10.29	$10.29	$0.00
Bell Road	$15.64	$15.64	$0.00
Camelback Road	$11.53	$4.91	-$6.62
Chandler Boulevard	$6.59	$6.59	$0.00
Main Street	$5.35	$5.35	$0.00
Power Road	$3.71	$3.71	$0.00
Scottsdale Road	$15.23	$14.00	-$1.23
SR-51	$10.71	$9.47	-$1.24

Dedicated BRT Corridor	Previous (Milestone 4) Annual O&M Cost ($ millions)	Revised Annual O&M Cost ($ millions)	Change in O&M Cost (MS 4 to MS 5)
Union Pacific Chandler Branch	$7.41	$7.00	-$0.41
Grand Avenue	n/a	$15.91	n/a

Notes: The Milestone 4 costs presented for SR-51 are the Glendale Ave/Cactus Ave costs produced in Milestone 4. No Dedicated BRT costs were produced in Milestone 4 for the SR-51 corridor.

Cost Effectiveness and Benefit Cost Analysis

The calculation of cost effectiveness remains the same from the previous Milestone report. As noted previously, this calculation does not match the Federal "New Starts" cost effectiveness calculation exactly. This difference is a result of the reliance of the New Starts' cost effectiveness figure being based upon "new" riders attracted to use the transit service. The use a sketch planning model does not allow for determining the number of new transit riders attracted to each corridor.

The objective of the cost effectiveness calculation in this study is for a comparison between the proposed transit corridors. The calculation used to compare the benefits of each corridor is:

(Project Annualized Capital Cost + Project Annual Operating Cost)/Project Annual Boardings = Cost Effectiveness

The annualized figure for capital cost is obtained by multiplying the total project capital cost by 0.08 to annualize the figure over the expected useful life of the improvements. Calculations were performed using the New Starts' process for annualizing capital costs to determine the expected useful life differences between commuter rail, LRT, and BRT vehicles. These calculations resulted in annualization factors ranging from 0.078 to 0.083 for the various technologies. This spread of annualization factors results in an insignificant difference in annualized cost and the overall cost effectiveness.

Boardings are annualized for the four commuter rail corridors by multiplying the weekday boarding figure by an annualization factor of 300. A refinement has been made the annualization factor for the LRT/Dedicated BRT corridors. Previously, boardings in these corridors were annualized using 300 for the annualization figure. The MAG LRT sketch-planning model produces daily boarding figures, which include Saturday and Sunday service. The commuter rail sketch-planning model produces weekday boarding figures. This distinction means that an annualization factor of 365 would be more appropriate to accurately annualize the daily LRT boarding figure. The change in annualization has resulted in a proportional improvement in cost-effectiveness figures for the LRT/Dedicated BRT corridors. Given the equally proportional improvement in these cost effectiveness figures, this adjustment has not resulted in a change to the corridors contained in the Recommended High Capacity Transit Network. There is no effect upon the commuter rail cost-effectiveness figures, and there is no effect to the recommendations for inclusion of selected the commuter rail corridors in the Recommended Network.

In case of corridors identified as possibly LRT or Dedicated BRT, the LRT cost effectiveness figure has been presented.

The cost effectiveness figures presented in this report are designed as a tool to compare the corridors under consideration in the High Capacity Transit Plan. It would not be appropriate or accurate to compare these figures to other projects such as the CP/EV LRT or other transit projects which have received a certain cost effectiveness rating from the Federal Transit Administration (FTA). This measure differs significantly from the measure used in this study. The High Capacity Transit Plan cost effectiveness rating should be used only to evaluate the corridors in this report against each other.

Table 5.0-20 summarizes the results of the refined cost effectiveness calculations.

Table 5.0-20	Cost Effectiveness

Corridor	Length (miles)	Boardings per Mile	Weekday Boardings	Annual Boardings	Capital Cost per Mile	Total Cost	Annual Capital Cost	Annual Operating Cost	Revised Cost Effectiveness	Previous Cost Effectiveness
59th Ave	18.99	676	12,829	4,682,585	$38.33	$727,809,264	$58,224,741	$11,290,000	$14.85	$12.38
Bell	28.55	692	19,750	7,208,750	$38.61	$1,102,239,771	$88,179,182	$22,550,000	$15.36	$13.21
BNSF	26.18	617	16,145	4,843,500	$28.19	$737,933,062	$59,034,645	$22,550,000	$16.84	$29.17
Camelback	8.63	942	8,126	2,965,990	$40.48	$349,356,895	$27,948,552	$7,630,000	$12.00	$12.16
Central South	4.93	1,166	5,749	2,098,385	$46.25	$228,033,946	$18,242,716	$4,830,000	$11.00	n/a
Chandler Blvd.	16.45	743	12,226	4,462,490	$41.57	$683,750,317	$54,700,025	$9,740,000	$14.44	$16.51
Chandler Branch	12.6	995	12,534	4,574,910	$36.58	$460,856,044	$36,868,484	$10,440,000	$10.34	$8.57
Glendale Avenue	9.75	741	7,226	2,637,490	$44.02	$429,215,236	$34,337,219	$8,960,000	$16.42	$11.95
I-10 West	11.05	1,246	13,765	5,024,225	$36.14	$399,343,813	$31,947,505	$10,290,000	$8.41	$11.09
Main	9.64	1,006	9,697	3,539,405	$38.76	$373,625,175	$29,890,014	$8,960,000	$10.98	$13.02
Metrocenter/I-17	8.75	1,011	8,848	3,229,520	$38.59	$337,645,412	$27,011,633	$7,610,000	$10.72	$14.84
Power	13	666	8,653	3,158,345	$35.78	$465,103,053	$37,208,244	$8,260,000	$14.40	$14.95
Scottsdale Rd/Tempe Br	25.5	811	20,672	7,545,280	$39.64	$1,010,837,127	$80,866,970	$20,950,000	$13.49	$14.97
SR-51	17.34	711	12,334	4,501,910	$47.48	$823,278,568	$65,862,285	$14,340,000	$17.82	$27.09
UP Mainline/Chandler	27.95	163	4,561	1,368,300	$18.97	$530,221,490	$42,417,719	$14,250,000	$41.41	$56.96
UP Southeast	36.18	171	6,198	1,859,400	$15.69	$567,495,110	$45,399,609	$17,500,000	$33.83	$35.70
UP Yuma	30.9	389	12,034	3,610,200	$14.62	$451,799,232	$36,143,939	$22,400,000	$16.22	$27.04
Grand Avenue BRT	25.8	456	11,770	4,296,050	$9.01	$232,478,126	$18,598,250	$15,910,000	$8.03	n/a

Several corridors have improved their cost effectiveness rating dramatically since the previous review in Milestone 4. This shift in cost effectiveness is directly attributable to the changes in ridership estimates resulting from the revised population projections for the MAG region. However, not every corridor benefited from the revised population forecasts. Several LRT/Dedicated BRT corridors in the East Valley did not perform as well as result of lower ridership estimates. Several LRT/Dedicated BRT corridors received worse cost-effectiveness ratings as result of the modifications made to the station catchment areas. This effect was mitigated on some corridors due to the increased population and estimated ridership gain. I-10 West, Metrocenter/I-17, and SR-51 were the only LRT/Dedicated BRT corridors experiencing a large enough ridership gain to overcome the effect of the revised station spacing.

These results make commuter rail service in the BNSF and UP Yuma corridors much more viable when compared to the other recommended corridors. The UP Southeast and UP Mainline/Chandler corridors still face challenges given the anticipated cost of implementing service. In light of these challenges a recommendation has been made to eliminate the UP Mainline/Chandler corridor from consideration for commuter rail service. Nevertheless, it is recognized that this corridor on the UP Chandler Industrial Branch portion between Chandler and Mesa has a large level of travel demand. Given the results of the cost-effectiveness evaluation performed in this Milestone and Milestone 4 it is apparent that this demand would be best served by an LRT/Dedicated BRT corridor paralleling the UP Chandler Branch. Commuter rail demand in the corridor between Mesa and downtown Phoenix would still be served by the UP Southeast corridor. The UP Chandler Branch corridor was specifically reviewed in this analysis and received an excellent cost effectiveness rating (2nd overall). Given this performance by the LRT/Dedicated BRT technology, it is recommended that commuter rail no longer be studied for this corridor.

Despite the lower performance of the UP Southeast corridor compared to the other high capacity transit corridors contained in the recommended network, this corridor remains in consideration for high capacity transit service. This decision has been made considering the regional travel demand in the East Valley and the probable need for fast, long-distance transit service in this portion of the MAG region. Commuter rail is better suited to meeting this demand than are LRT and Dedicated BRT. Several challenges in terms of cost are faced by the UP Southeast corridor. However, as shown in Section 5.1.1 above, there are alternative operating strategies and technologies which could be implemented to reduce the overall cost of building and operating commuter rail service. These alternatives are promising enough to recommend that commuter rail in the UP Southeast corridor remain in the recommended network of high capacity transit corridors.

At this point in time, this study has a limited ability to produce direct comparisons between LRT and BRT in cost-effectiveness. The MAG Sketch-Planning Model is not capable of distinguishing between LRT and BRT technologies, preventing estimates of the differences in ridership between corridors. However, using the single estimated ridership figures, it is possible to identify specific corridors that would likely perform well with Dedicated BRT service. Corridors with lower ridership figures would be prime candidates for BRT service, because the BRT technology would be capable of providing a comparable level of service at a much lower cost. Given this situation a comparison between the cost-effectiveness figures for LRT and BRT is warranted. Table 5.0-21 summarizes the cost effectiveness of both transit technologies in various corridors in the MAG region.

Table 5.0-21 **LRT-BRT Cost Effectiveness Comparison**

Corridor	LRT Annualized Cost (Capital and O&M) $ millions	BRT Annualized Cost (Capital and O&M) $ millions	LRT Cost Effectiveness	BRT Cost Effectiveness
59th Avenue	$69.51	$40.02	$14.85	$8.55
Bell Road	$110.73	$65.68	$15.36	$9.11
Camelback Road	$35.58	$20.88	$12.00	$7.04
Chandler Boulevard	$64.44	$34.22	$14.44	$7.67
Main Street	$38.85	$28.51	$10.98	$6.23
Power Road	$45.47	$38.85	$14.40	$10.98
Scottsdale Road	$101.82	$27.21	$13.49	$8.61
SR-51	$80.20	$58.23	$17.82	$7.72
Union Pacific Chandler Branch	$47.31	$34.71	$10.34	$7.71

Additional discussion comparing the capabilities of LRT and BRT is provided in Section 5.0.3. Suggested recommendations for technologies in each corridor are provided in Section 5.2.

The results of this refined evaluation of cost effectiveness will have a dramatic effect upon recommendations for phasing and timing for service in the recommended high capacity transit network. The full scope of these changes to corridor prioritization will be presented in Section 5.3.3.

Benefit Cost Analysis

This section presents the results of the simplified, sketch-planning level benefit cost analysis for 18 corridor-technology scenarios. The benefit-cost analysis results provide the means both to assess the "worth" of each project as well as to rank the projects against each other for purposes of prioritization. The scenarios are listed in Table 5.0-22.

The 18 scenarios contain all 13 potential LRT corridors. In addition, two representative corridors, Main Street and 59th Avenue, were selected for comparison between LRT and dedicated BRT technologies. These two corridors were selected for the comparison because they are representative of the diverse geographical areas of the valley.

The commuter rail corridors analyzed are the BNSF, UP Yuma and UP Southeast (all Phase 3 service levels). The UP Mainline/Chandler corridor was not included since the cost effectiveness analysis shows its potential ridership could be more effectively served by an LRT/Dedicated BRT corridor.

Table 5.0-22 **MAG High Capacity Transit Scenarios Evaluated**

Scenario Number	Corridor	Technology
1	Camelback Road	LRT
2	UP Chandler Branch	LRT
3	Main Street	LRT
4	Main Street	Dedicated BRT
5	Metrocenter/I-17	LRT
6	Glendale Avenue	LRT
7	59th Avenue	LRT
8	59th Avenue	Dedicated BRT
9	Bell Road	LRT
10	Chandler Boulevard	LRT
11	I-10 West	LRT
12	Power Road	LRT
13	Scottsdale/UP Tempe	LRT
14	SR-51	LRT
15	BNSF Phase 3	Commuter Rail
16	UP Yuma - Phase 3	Commuter Rail
17	UP Southeast - Phase 3	Commuter Rail
18	Central Avenue South	LRT

Table 5.0-23 describes the general categories of benefit included in the benefit-cost analysis. The categories are most easily understood when described in terms of the different groups that benefit from the transit service.

Table 5.0-23 **Taxonomy of Transit Benefit**

Sources Of Benefit	Recipients Of Benefit		
	Transit Users	Highway Users	Area Communities
Mobility	Access to employment, day-care, shopping and other destinations for low income people	Greater accessibility to employment and other destinations	Reduced financial burdens on home-based and welfare-to-work social services
Community Livability and Development	Wider range of life-style choice	Time savings in local neighborhoods; more destinations accessible by walk or wheelchair	Greater range of affordable housing; Greater neighborhood diversity and social mix
Sustained Congestion Management in Major Corridors	Sustainable time savings, reliability and predictability in journeys to work and non-work places	Sustainable time savings, reliability and predictability in journeys to work and non-work places	Less pollution and greenhouse gases; Improved Safety; Reduction in sustained outlays on highway infrastructure

Findings

Table 5.0-24 ranks the 18 scenarios by benefit-cost ratio.

Table 5.0-24 **MAG High Capacity Transit Project Life Cycle Evaluation Measures (Ranked by Benefit-Cost Ratio)**

Benefit-Cost Rank	Corridor	Technology	Benefit-Cost Ratio
1	UP Yuma - Phase 3	Commuter Rail	4.19
2	I-10 West	LRT	2.64
3	SR-51	LRT	2.28
4	59th Avenue	Dedicated BRT	2.04
5	Metrocenter/I-17	LRT	1.87
6	Bell Road	LRT	1.75
7	BNSF Phase 3	Commuter Rail	1.69
8	Scottsdale/UP Tempe	LRT	1.61
9	59th Avenue	LRT	1.39
10	Camelback Road	LRT	1.31
11	UP Southeast - Phase 3	Commuter Rail	1.30
12	Main Street	Dedicated BRT	1.11

Benefit-Cost Rank	Corridor	Technology	Benefit-Cost Ratio
13	Glendale Avenue	LRT	1.05
14	Chandler Boulevard	LRT	0.97
15	UP Chandler Branch	LRT	0.96
16	Main Street	LRT	0.78
17	Power Road	LRT	0.72
18	Central Avenue South	LRT	0.50

Notes: All benefits and costs are in Year 2001 dollars, with a 4% real discount rate

The benefit-cost analysis, like the cost effectiveness calculation, reflects the relationship between ridership and costs within each scenario. However, it is important to recognize that the key additional factor at work in the benefit-cost analysis is the level of roadway congestion forecast for the competing arterial or freeway segment. Transit services competing against roadways that are highly congested will generate high levels of travel time and vehicle operating cost savings. These congestion management benefits constitute a large proportion of the total project benefits in the highest ranked corridors above. Conversely, congestion management benefits from new transit services are lower both in absolute and relative terms in scenarios where roadway congestion will be minor. The results of the benefit-cost analysis could change based on the run of the MAG travel demand model if it is determined that revised congestion levels are markedly different from those assumed in this analysis.

There is considerable variation in results among the scenarios. The benefit-cost ratio ranges from 4.19 in the case of the UP Yuma commuter rail scenario to 0.50 for the Central Avenue South LRT line. Five of the 18 scenarios generate costs in excess of benefits.

As a group, the commuter rail corridors show positive results due in part to the strong ridership forecasts for the West Valley lines. A significant contributing factor is the higher diversion rate from autos that was assumed. In addition, the longer length of the commuter rail corridors compared to the others tends to increase the relative congestion management benefits generated. On the other hand, the commuter corridors exhibit lower benefits in the low income mobility and liveable community categories since a lower percentage of commuter rail riders belong to low income groups.

The strong performance of UP Yuma and the other commuter rail corridors is magnified by the assumed diversion rate of 75 percent from autos compared to 50 percent for LRT and BRT scenarios. As a rule, commuter rail services tend to divert a greater proportion of trips from autos than LRT and BRT services. Commuter rail can be considered a “premium” service compared to the other technologies due to factors such as longer spacing between stations, higher line haul speeds, and more spacious seating. When compared to LRT and BRT, commuter rail often captures a higher proportion of home to work trips occurring during congested peak hours. These are the times of the day when the competitive advantage of transit is greatest.

The primary reason that the UP Yuma scenario generates benefits of such magnitude is the extremely high level of congestion on the competing highway corridor, I-10. In 2040 it is forecast to take more than 6.5 times as long to travel the length of the corridor at peak times than during free flow conditions.

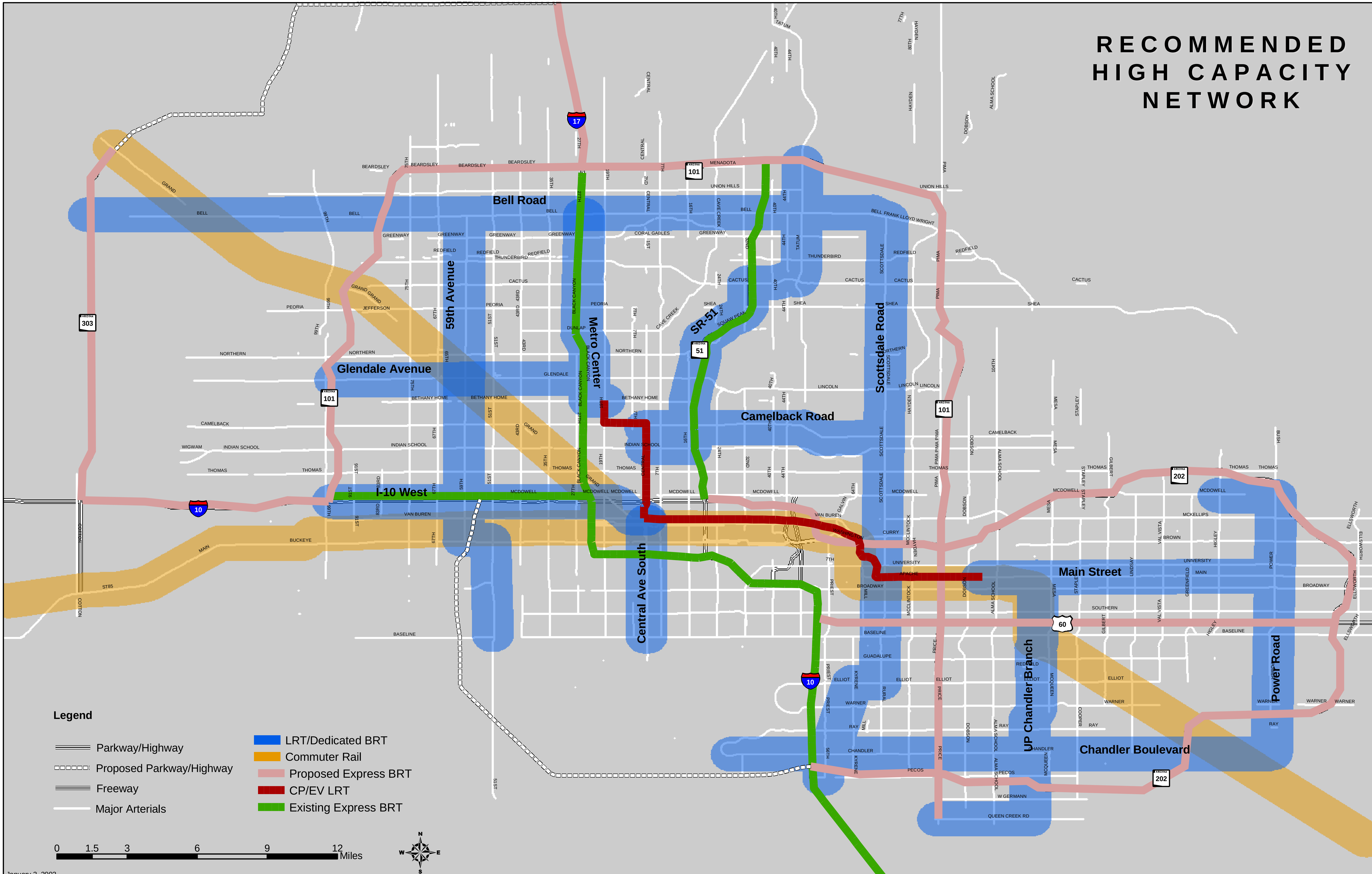
The high level of congestion on I-10 is also the major cause of the high ranking for Scenario 11, I-10 West LRT. High levels of roadway congestion are a significant factor in the high ranking of the SR-51 scenario as well. The results for the UP Yuma, I-10 West, and SR-51 are higher than are typically seen in the consultant team's analyses of similar projects.

The lower relative costs of the BRT scenarios compared to their LRT counterparts cause them to score higher given that ridership is the same for both technologies. This outcome occurs in spite of the smaller community development benefits generated by BRT: the development impact area for BRT encompasses a 0.25-mile radius while a 0.5-mile radius is assumed for LRT. Emissions benefits are significantly lower for BRT as compared to LRT, and in fact both BRT scenarios generate a negative benefit in the emissions category. The one caveat to this result is the expected lower ridership levels that would be generated by a BRT system when compared to an LRT system. This difference in ridership levels would likely result in a reduction in the advantage BRT has over LRT.

5.0.2 MAG Region High Capacity Transit Network

The overall objective of the Recommended High Capacity Transit Network is the creation of an integrated system of high capacity transit corridors providing efficient and convenient travel throughout the MAG region. An important part of these corridors fulfilling their objective is to insure that there are connections between the corridors and that these connections facilitate the movement of riders between systems no matter which transit technology is being operated. Exhibit 5.0-4 illustrates the Recommended High Capacity Transit Network.

Exhibit 5.0-5 illustrates the Recommended High Capacity Transit Network as an integrated network of corridors. The likely connection points between each corridor and intersecting corridors are illustrated in this map along with the connections made to the assumed base high capacity transit corridors such as the CP/EV LRT and the proposed Phoenix Express BRT system.


RECOMMENDED HIGH CAPACITY NETWORK
Bell Road
Glendale Avenue
59th Avenue
Metro Center
SR-51
Camelback Road
Scottsdale Road
I-10 West
Central Ave South
Main Street
UP Chandler Branch
Chandler Boulevard
Power Road
Legend
Parkway/Highway
Proposed Parkway/Highway
Freeway
Major Arterials
LRT/Dedicated BRT
Commuter Rail
Proposed Express BRT
CP/EV LRT
Existing Express BRT
0 1.5 3 6 9 12 Miles
January 3, 2003
Network Map - Wide Corridors


RECOMMENDED HIGH CAPACITY TRANSIT NETWORK
Surprise
ElMirage
Peoria
Bell Road
Glendale Avenue
59th Avenue
W. Phoenix Glendale
Metro Center
SR-51
Camelback Road
Scottsdale Road
I-10 West
Tolleson
West Phoenix
Downtown Phoenix
Sky Harbor
Downtown Tempe
East Tempe
Main Street
Mesa
Goodyear
Buckeye
Central Avenue South
UP Tempe Branch
UP Chandler Branch
Chandler Boulevard
Power Road
Gilbert
Williams Gateway
Queen Creek
Legend
Station
Connection
Commuter Rail
CP/EV LRT
Existing Express BRT
LRT/Dedicated BRT
Proposed Express BRT
Freeway
Proposed Freeway/Parkway/Highway
Major Arterials
0 1.25 2.5 5 7.5 10 Miles
DRAFT: December 31, 2002

Feeder System Role

Even though the majority of feeder networks are expected to be provided by the existing transit network, there may be a need for a feeder bus network to link with high capacity transit services. Key considerations when determining whether feeder bus services are warranted include:

- Proximity to employment sites and limited or no existing transit service
- Capacity constraints as defined by parking availability and affordability
- Direct transit service connections to nearby activity centers
- Community support
- Private sector funding

These criteria were discussed in detail in Milestone 4. Although it is not possible to identify exactly which stations warrant feeder bus service at this time, it is valuable to note that where stations are more than one-half mile from a major activity center, then feeder bus service may be needed. Since the proposed high capacity transit service is a long-term plan, significant growth in several cities is expected to occur in the next 20 years. For example, in Scottsdale a major new shopping development is planned and in Surprise, a major sports complex will come on line in this timeframe. Depending on the exact citing of the stations, a feeder bus service may be an attractive element of the high capacity transit service, and funded, in part, by the new developments.

Feeder bus service can offer a high quality and convenient connection from rail stations to nearby destinations, such as an employment or commercial sites or other major activity centers. Where feeder bus service is warranted, it is viewed as an integral extension of the rail service and without it service may not be very attractive. A well designed and run feeder bus service enhances the overall attractiveness of the rail service.

<u>Light Rail</u>

The proposed frequency for the light rail corridors during peak periods range between ten minutes and 15 minutes. This means that feeder bus service needs to be provided frequently to meet every train. The more frequent the service the more costly the service. Light rail station stops along a light rail corridor line tend to be spaced closer together than commuter rail, which may also mean more bus feeder routes.

<u>Commuter Rail</u>

Commuter rail station stops tend to be further spaced than light rail stations and they operate less frequently. This means that feeder bus services are even more important at commuter rail stations and must achieve excellent schedule coordination for the service to be successful.

High Capacity Transit and the Developing Valley Metro Network

High capacity transit services will effectively replace some local bus services, but much of Valley Metro's growing grid system will remain intact. Even with high capacity transit services in operation, fixed route and shuttle bus services will continue to provide important local circulation in many of Maricopa County's communities, as well as some regional BRT Express services on freeways, utilizing park-and-ride lots and HOV lanes.

A separate ongoing project, the Valley Metro Regional Transit System Study, is identifying the local and express bus network for Maricopa County for 2025. That study is modeling transit demand based on changes in population growth, land use and densities over the next 25 years. The focus of the study it to identify the need for bus transit services based on density and transit dependence. The transit-dependent market — a significant component of the analysis as part of the Regional Transit System Study — is one of many markets that would be served by a high capacity transit system. The methodology for assigning services as part of the Regional Transit System Study was similar to the effort undertaken for the High Capacity Transit Study, but with one key difference: the High Capacity Transit Study has a limited number of corridors where services can be implemented, and corridors cannot be defined as narrowly as they are in the Regional Transit System Study.

All of the alternatives for LRT/BRT operate in the higher density corridors that have been targeted by Regional Transit System Study planners for fixed route and commuter connection bus service. For example, the Camelback Road Corridor has been identified by High Capacity Transit planners as an important corridor for BRT/LRT, particularly since Camelback Road congestion is projected to increase by 30% between now and 2040. Employment density along this corridor is among the highest in the region, and population density is also strong. This mix of high employment and population density contributes to making this an attractive corridor for high capacity services, but the mix of land uses also suggests a high number of local trips may be better served by the fixed route bus system.

5.0.3 Implementation Plan

An important component in developing a recommended high capacity transit network is determining when and how the corridors should be implemented. Proper phasing of projects is essential to ensure that growing ridership demands are met and that improvements are scaled to funding levels available. Included here is a brief overview of phased implementation of transit services, why it is done, a recommended prioritization of the corridors, a discussion about technology selection, and an action plan detailing the next steps in moving closer to corridor implementation.

The levels of service described for each of the commuter rail, LRT, and Dedicated BRT corridors in this report represent the *ultimate level of service* that each transit technology must provide to accommodate the ultimate estimated ridership demand in the various corridors. This ultimate level of service would be achieved at full development of the system. In reality, the development of service would be implemented in phases over a period of years, as underlying population and employment growth drives new ridership. Several criteria are involved in determining the phasing-in of new high capacity transit service. These criteria are essentially similar from technology to technology; however, there are distinctive differences. A general overview of why phasing is a preferred option for implementing high capacity transit along with a description of phasing steps for each technology are presented below.

<u>Commuter Rail</u>

As described in the ridership and cost estimates, this report has explored three major phasing steps for implementing commuter rail service. Each phase represents a dramatic improvement in service above the previous level of service. There are several ways of transitioning between levels of service. This transition can be done incrementally with only a single roundtrip train added each year, or improvements can be implemented through a larger change from one phase to the next. The driving factors behind the pace of implementing later phases of commuter rail will be funding availability and ridership growth. The three major phases of commuter rail implementation are described below:

Start-up Phase – Peak period service only, consisting of two or three trains inbound during the morning peak and outbound in the evening peak.

Intermediate Phase – Additional peak period service in peak direction is provided. Midday service and reverse commute service in the peak period are also implemented.

Ultimate Phase – The maximum amount of commuter rail service that a corridor can support. Very frequent peak service in both directions and expanded off-peak service with a span of service of 15 to 19 hours daily.

<u>Light Rail</u>

Light rail is a very different technology from commuter rail in terms of its operating characteristics. LRT systems are designed to provide frequent, all-day service from the first day of implementation, unlike commuter rail which can be a viable service with only two to three trains operating each day. A primary reason for this initial implementation of frequent service is the large amount of capital investment required to implement LRT.

Phasing in of LRT service would primarily consist of gradual shortening of headways and increased spans of service. Many LRT systems will open with 10 to 15 minute headways during peak periods and 20 to 25 minutes in off-peak times. As ridership levels grow headways would be shortened to five minutes or less during peak times and 10 minutes or less during off-peak.

Bus Rapid Transit

BRT technology is similar to commuter rail in that the phasing of service is very flexible, and can be implemented of a series of small stages over time to allow for funding availability and ridership growth. The lower infrastructure requirements for BRT allow for minimal levels of investment to begin a basic service and the flexibility of BRT vehicles allows for a staged implementation over many years.

The Metro Rapid service in Los Angeles is an example of rapid bus technology.

The first phase of BRT service is typically the implementation of a "rapid" or limited stop bus service with signal priority and special vehicles and stations. Because of the flexibility of this phase of BRT service and the overall limited capital investment required, rapid bus could also be used as an initial phase building up the implementation of an LRT system. Once the LRT service is in place the buses used to operate rapid bus service could be reassigned to other corridors.

Bus lanes represent the next phase in implementing BRT service. These lanes are usually located on the curb side of an arterial street and can either be exclusive or allow for some vehicle traffic during off-peak times or at intersections for turning movements.

Exclusive bus lanes separated from vehicle traffic either in the street median or an exclusive right-of-way such as a former freight railroad corridor represents the ultimate phase of BRT service. This service requires the greatest level of capital investment, but is capable of providing faster service than other forms of BRT as a result of the exclusivity of operations from cross traffic interference.

Phasing and Prioritization

Overall phasing of service may result in the total long term capital cost of implementing transit service to be higher than if the service was implemented at full capacity immediately. However, the latter approach is not usually realistic given the cost investment required to implement a full service transit system. Similar to the development of a freeway network when a six lane freeway is widened to eight lanes to meet growing demand, improvements are done to transit systems in phases to match growing ridership demand. This spreads the cost burden over several years or possibly decades allowing for benefits to be provided at an earlier stage than if construction was delayed until the full system could be implemented.

The High Capacity Transit Plan is designed to be the first step in developing and prioritizing the recommended network of high capacity transit services in the MAG region. This prioritization will continue at a more detailed level during the development of the MAG Regional Transportation Plan (RTP). One of the main objectives of the RTP will be to set out a specific prioritization of the transit corridors identified in the recommended network using additional analysis of population and employment projections, an estimation of expected funding availability, and extensive public consultation.

The 16 corridors contained in the Recommended High Capacity Transit Network have been categorized into three groups for the purposes of prioritization. The key considerations in setting forth the prioritization recommendations for the High Capacity Transit network are both quantitative and qualitative. They include:

- Analysis of expected population growth levels and anticipated timing of this future growth: the study scope approaches the potential demand for the high capacity transit system at full build-out of population and employment for the MAG region. However there are major differences in the rates at which this growth will generate appropriate thresholds of ridership across the region and within the corridors. The study has undertaken a review of the latest DRAFT2 socioeconomic forecasts at Traffic Analysis Zone levels to assess the likely build up of ridership to targeted 2040 levels.

- Estimated ridership.

- Linkages to the committed network of high capacity transit: the high capacity transit network is intended to enhance regional mobility. As such, connectivity with other elements of the network, including those which are natural extensions of the LRT and BRT networks which are already funded (CP/EV LRT, Central Avenue/Phoenix BRT corridors) are a key consideration in identifying early gains from high capacity transit development.

- The cohesiveness of the overall network, ensuring that future corridors link to previously implemented corridors.

The three groups of corridors identified here have been classified as the Short-Term, Middle-Term, and Long-Term Implementation corridors. Assuming a 40 year horizon for the population and employment projections used in this report, the Short-Term corridors would likely be recommended for implementation during the next 15 years, while the Middle-Term corridors would be implemented within a 15-30 year time frame. The Long-Term corridors would complete the high capacity transit network during the final ten years of the study period (2030 to 2040). It is essential to note that these classifications are not permanent. They are designed as a guide for future refinement as part of the RTP process. Changes in population growth levels, timing, and the location of future growth would result in changes to the corridors contained in each level.

Implementation of Corridors

The first set of corridors have been placed into the Short-Term Implementation category for several reasons including their performance in the cost effectiveness and Benefit Cost analysis, the objective of creating an integrated regional high capacity transit network resulting from the connections these corridors provide to the planned CP/EV LRT, and the objective of bringing some form of high capacity transit service to as many areas of the MAG region as possible during the first half of the planning horizon period. These criteria and objectives have resulted in the following recommendations for the Short-Term Implementation corridors:

- BNSF (Start-up Phase – Downtown Phoenix to Bell Road)
- Camelback Road
- Glendale Avenue
- I-10 West
- Main Street
- Metrocenter/I-17
- Scottsdale Road/UP Tempe Branch (Downtown Scottsdale to CP/EV LRT)
- SR-51 (Central Avenue to Cactus Avenue)
- UP Southeast (Start-up)
- UP Yuma (Start-up)

The Medium-Term corridors are:

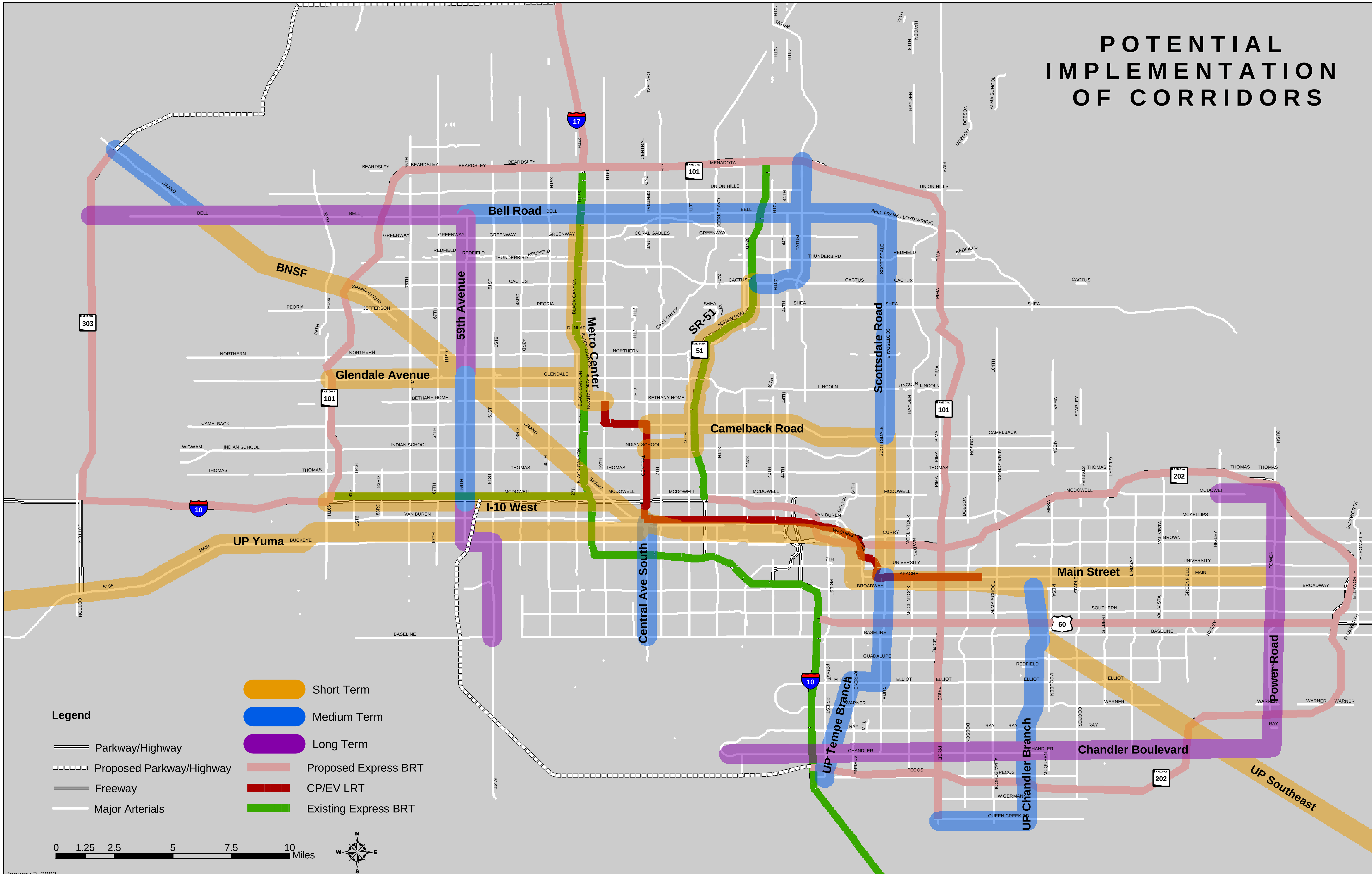
- 59th Avenue (Glendale Avenue to I-10 West)

- Bell Road (Scottsdale Road to 59th Avenue)
- BNSF (Start-up to Loop 303, Utimate to Bell Road)
- Central Avenue South
- Scottsdale Road/UP Tempe Branch (North of Downtown Scottsdale and South of CP/EV LRT)
- SR-51 (Cactus Avenue to Loop 101)
- UP Chandler Branch
- UP Southeast (Start-up with reverse commute to Williams Gateway)
- UP Yuma (Ultimate)

The Long-Term corridors are classified as such because of the timing of future growth during the outlying years of the study horizon. Earlier implementation of these corridors would not be cost effective due to the lower ridership base that would be available. The corridors are:

- 59th Avenue (Bell Road to Glendale Avenue and I-10 West to Baseline Road)
- Bell Road (59th Avenue to Loop 303)
- BNSF (Ultimate to Loop 303)
- Chandler Boulevard
- Power Road
- UP Southeast (Ultimate)

There are recommendations for phased implementation of several of the corridors listed above. The characteristics of these phased implementations are described in Section 5.3.2. Specifically, the commuter rail corridors will require phased implementation and a period of time in which to build ridership and upgrade the existing rail infrastructure. The Scottsdale Road/UP Tempe Branch corridor is recommended for implementation in two phases as a result of the higher existing congestion and density between downtown Scottsdale and the planned CP/EV alignment. Growth in portions of this corridor to the north and south of these limits occurs further out in the future, allowing for some delay in implementing service. Exhibit 5.0-6 illustrates these corridors together as the Recommended High Capacity Transit Network.


POTENTIAL IMPLEMENTATION OF CORRIDORS
Bell Road
BNSF
59th Avenue
Metro Center
SR-51
Scottsdale Road
Glendale Avenue
Camelback Road
I-10 West
UP Yuma
Central Ave South
Main Street
UP Tempe Branch
UP Chandler Branch
Chandler Boulevard
Power Road
UP Southeast
Legend
Short Term
Medium Term
Long Term
Parkway/Highway
Proposed Parkway/Highway
Freeway
Major Arterials
Proposed Express BRT
CP/EV LRT
Existing Express BRT
0 1.25 2.5 5 7.5 10
Miles
N
W
E
S
January 3, 2003
Potent Implement of corriodrs 3 levels

Technology Comparison

The Benefit Cost analysis presented in Section 5.1.3 includes a comparison of LRT and BRT technologies on two of the recommended high capacity transit corridors, Main Street and 59th Avenue. This comparison is primarily related to the overall cost for each project as actual differences in ridership are not available given the sketch planning model's limitations in distinguishing between the two technologies. From a cost standpoint BRT would likely provide more benefit than LRT in a specific corridor. However, there are other issues including ridership, frequency of service, and overall capacity that also must be considered before a recommended technology can be selected. In high ridership corridors, LRT may be the preferred technology based upon meeting ridership demand even if there are higher capital costs involved.

The US General Accounting Office (GAO) published a report to the US Congress in September 2001 comparing LRT and BRT technologies for the purposes for evaluating future transit projects applying for Federal funding assistance. This report analyzed the capital and operating costs of both technologies as well as the real-world performance of each technology.

In terms of capital cost, the GAO report found that BRT has a decided advantage over LRT[1]. BRT systems surveyed in cities through the United States reported capital costs ranging from $200,000 to $55 million per mile depending upon whether the system was implemented in mixed-flow vehicle traffic or in an exclusive right-of-way. LRT systems reported an average cost of $12.4 million to $118.8 million per mile. This difference in cost correlates well with the capital cost estimates contained in Section 5.1 of this report. The Dedicated BRT corridors have an average per mile capital cost of $18.1 million, while the LRT corridors' average per mile cost is $39.7 million.

The GAO report did not reveal a major advantage for either technology in terms of operating costs. BRT typically will require more vehicles and shorter headways to provide a comparable level of service to LRT. This increased service reduces or eliminates any advantage in operating cost that a single bus would have over a single LRT train. Long term maintenance and vehicle replacement costs may favor LRT over BRT since LRT vehicles have a life cycle that is approximately double that of standard buses. The track infrastructure for LRT also usually maintains a longer life cycle than a paved BRT guideway. The annual operating costs presented for BRT and LRT in this report tend to slightly favor BRT technology. However, these planning level costs and a detailed refinement of headways and infrastructure replacement in specific corridors could eliminate this slight advantage.

[1] GAO Report: Bus Rapid Transit Shows Promise, September 2001.

In terms of operational characteristics BRT and LRT both have advantages and disadvantages that would need to be analyzed on a corridor-by-corridor basis in order to determine the right technology "fit" for new high capacity transit system. A detailed Major Investment Study (MIS), similar to the one performed by the Cities of Scottsdale and Tempe for a north-south transit corridor, is required to fully and properly analyze each technology for a corridor. The discussion that follows presents the general advantages and disadvantages of each technology on a non-corridor specific basis.

Bus Rapid Transit

Advantages

- Increased flexibility in operating environments (streets, HOV lanes, dedicated lanes, freight corridors)
- More flexible in phasing of expended service
- Ability to operate as short-term service prior to expanded BRT or LRT service

Disadvantages

- Image of bus vehicles as slow and dirty
- Reduced vehicle capacity

Light Rail

Advantages

- Positive impact upon land use development within the corridor
- Increased vehicle capacity

Disadvantages

- Limited ability for phased implementation
- Higher capital investment cost than BRT

Summary

Both transit technologies have a series of advantages and disadvantages that require analysis at a detailed corridor specific level to determine the appropriate technology for implementation. During the technology selection process it is important to consider the influence of other corridors in the regional recommended network. Each of these technologies is highly scalable and the implementation of one technology tends to encourage the continuation of that technology in future expansions and extensions of the initial corridor. This trend is a result of the economies of scale gained for expanding existing infrastructure and the possible negative effects on total ridership caused by bus-rail transfers. However, selecting one technology over the other does not preclude the implementation of both LRT and BRT in the same metropolitan region. These two technologies co-exist in many regions including Los Angeles, Pittsburgh, and Cleveland. In the end, technology selection is not only a local decision, it is a regional one that should include input from all stakeholders region-wide to order to bring the greatest benefit to the largest number of people.

Action Plan

The Recommended High Capacity Transit Network represents the culmination of a process that identified 28 potential high capacity transit corridors throughout the MAG region, refined these corridors, and evaluated them against each other to determine which corridors were best suited to serve growing demand for transportation capacity in the MAG region.

The next step in implementing the recommended network is the inclusion of these corridors in the development of the RTP. This study was the first step in the process of implementation. The next step is the RTP process which will involve a second review of the network corridors, a review of expect funding availability for transit improvements, and consultations with local agencies and the general public to further refine the number an coverage of the recommended corridors. This second review should result in a more precise prioritization of the corridors based upon further refined population projections, anticipated funding, and local agency support.

There are several specific next steps that need to be taken by MAG or local agencies in the MAG region either individually or in concert to ensure that proper preparations are made for providing future high capacity transit service in several of the corridors identified in the Recommended High Capacity Transit Network. Ideally these actions would begin immediately; however, given the need for approval of the RTP and its funding plan, some components may need to wait until the RTP is finalized. The tasks below are designed to be realistic objectives capable of being accomplished during the next three to five years. If these tasks are not completed in this timeframe, delays may be caused to later implementation steps and could delay components of the recommended network. The immediate actions are:

Refined Prioritization of Corridors in the RTP – The RTP process may introduce changes to the prioritization categories presented in Section 5.3.3 above. These changes must be determined early on so that local agencies understand the timing for funding availability and future implementation.

Relocation of the BNSF Freight Facilities – BNSF has been considering the relocation and consolidation of several freight rail facilities in downtown Phoenix to sites north of the BNSF mainline north of the existing intermodal facility in El Mirage. The elimination of this activity could create an opportunity for the negotiation of peak period operating windows to run the Phase 1 level of service in the BNSF corridor. The use of operating windows would substantially reduce the initial capital costs of implementing commuter rail service in the BNSF corridor, delaying the addition of a second main track until later phases of service.

The relocation of the BNSF facility is not a simple process and will require extensive consultations between BNSF, local cities in the corridor, MAG, the Federal Railroad Administration (FRA), and the general public. This will likely be a long process for gaining approval of all parties involved and the identification of funding. This time frame makes it imperative that discussions begin soon to determine the feasibility of this strategy.

Begin Negotiations with Union Pacific – Negotiating access rights to freight railroad corridors can be a long drawn-out process that lasts for as many as five to 10 years depending upon the railroad, the local agency, and the operating characteristics of the corridor. It will be important to have a full understanding of what types of access rights UP will allow in both the UP Yuma and UP Southeast corridors in order to determine what capital costs will be involved in possible track upgrades and additions.

Develop a Specific Commuter Rail Network Plan – Previous studies have already considered commuter rail, largely on a corridor basis, but not in the context of the High Capacity Transit network. The revised Milestone analysis of Commuter Rail suggests very attractive ridership performance for the Startup Phase of commuter rail. The High Capacity Transit Study level of analysis does not allow this conclusion to be tested rigorously as part of a standalone Commuter Rail Analysis. A separate action-oriented plan is needed to assess the viability of the startup service, take forward the initial discussions with UP and BNSF during the course of the High Capacity Transit Study, and run the network assumptions through an analysis based on the FTA New Starts criteria.

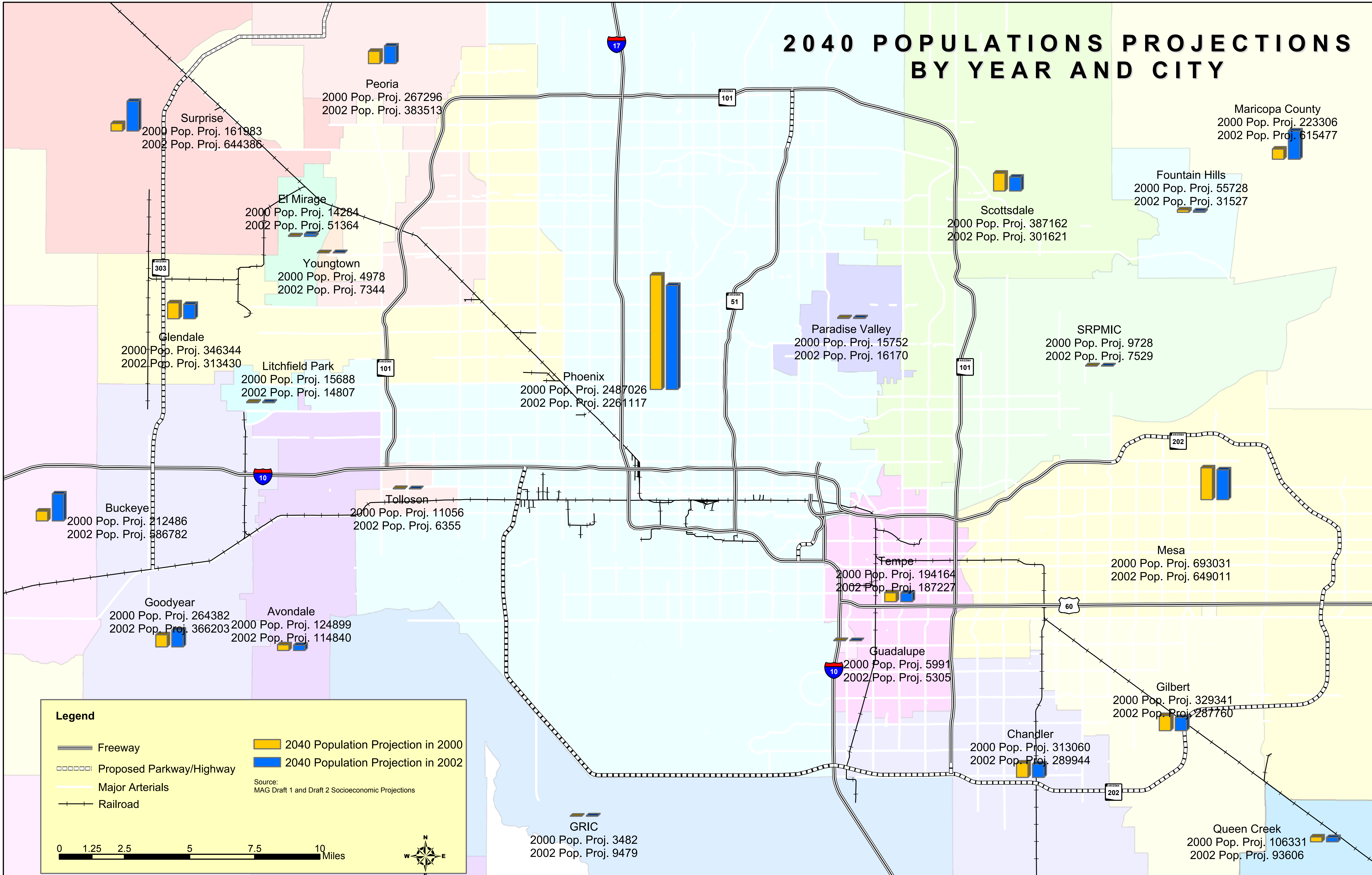
Perform Detailed Major Investment Studies on Early Implementation Corridors – Each corridor contained within the Recommended High Capacity Transit Network will require some form of Major Investment Study (MIS) to determine precise alignments, operating characteristics, preferred technology, and the overall design of the system. An MIS report includes a detailed refinement of costs, headways, and alignments, while including opportunities for community and policy input into the development of transit service. The outcome of an MIS is usually a more defined picture of what the high capacity transit service will look like in appear and operation. Several of these MIS efforts are underway or in early planning stages and include the Scottsdale-Tempe North-South Transit MIS and the City of Chandler Transit MIS, and this recommendation is not intended to be duplicative of these efforts. The work being done in these studies was incorporated into the development of corridors for evaluation in this report. Future MIS reports will build upon the corridors identified in the Recommended High Capacity Transit Network.

5.1 Refinement of Ridership and Cost Estimates

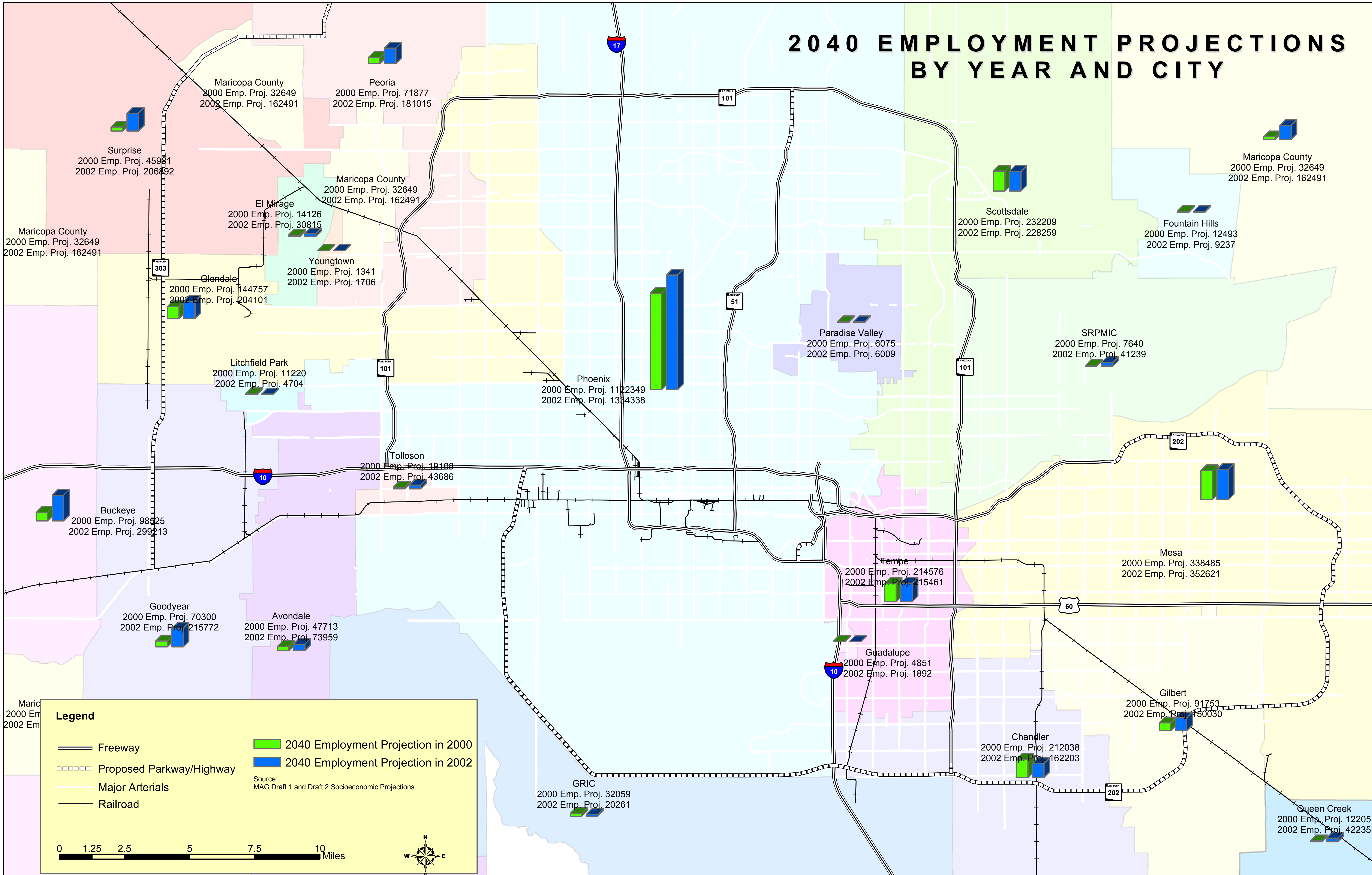
Contained within this section are refined ridership and cost estimates based upon modifications to selected corridors and new population projections. The Milestone 4 report contained ridership and cost estimates developed for 28 high capacity transit corridors featuring various technologies including commuter rail, light rail, and two forms of bus rapid transit, Dedicated and Express. These ridership and cost figures were used to evaluate each corridor for possible inclusion in a recommended network of high capacity transit services. Ridership estimates were generated using a sketch-planning model for commuter rail, light rail transit (LRT), and bus rapid transit (BRT) corridors.

The Milestone 4 sketch planning model results were originally based upon adopted population projections developed by the Maricopa Association of Governments (MAG) for a regional population of 6.4 million residents. This population projection was subsequently revised by MAG in consultation with local cities to more accurately reflect local General Plans and planned growth. The revised population forecasts resulted in a projected regional population of 7.4 million residents (MAG Draft 2 Socioeconomic Projections). A majority of this new growth was focused in the western MAG region in municipalities such as Buckeye, Surprise and Peoria. Several areas and municipalities in the MAG region have seen a reduction in future population levels as a result of the new projections, specifically in the East Valley and southern Phoenix, largely as a result of land use plan changes.

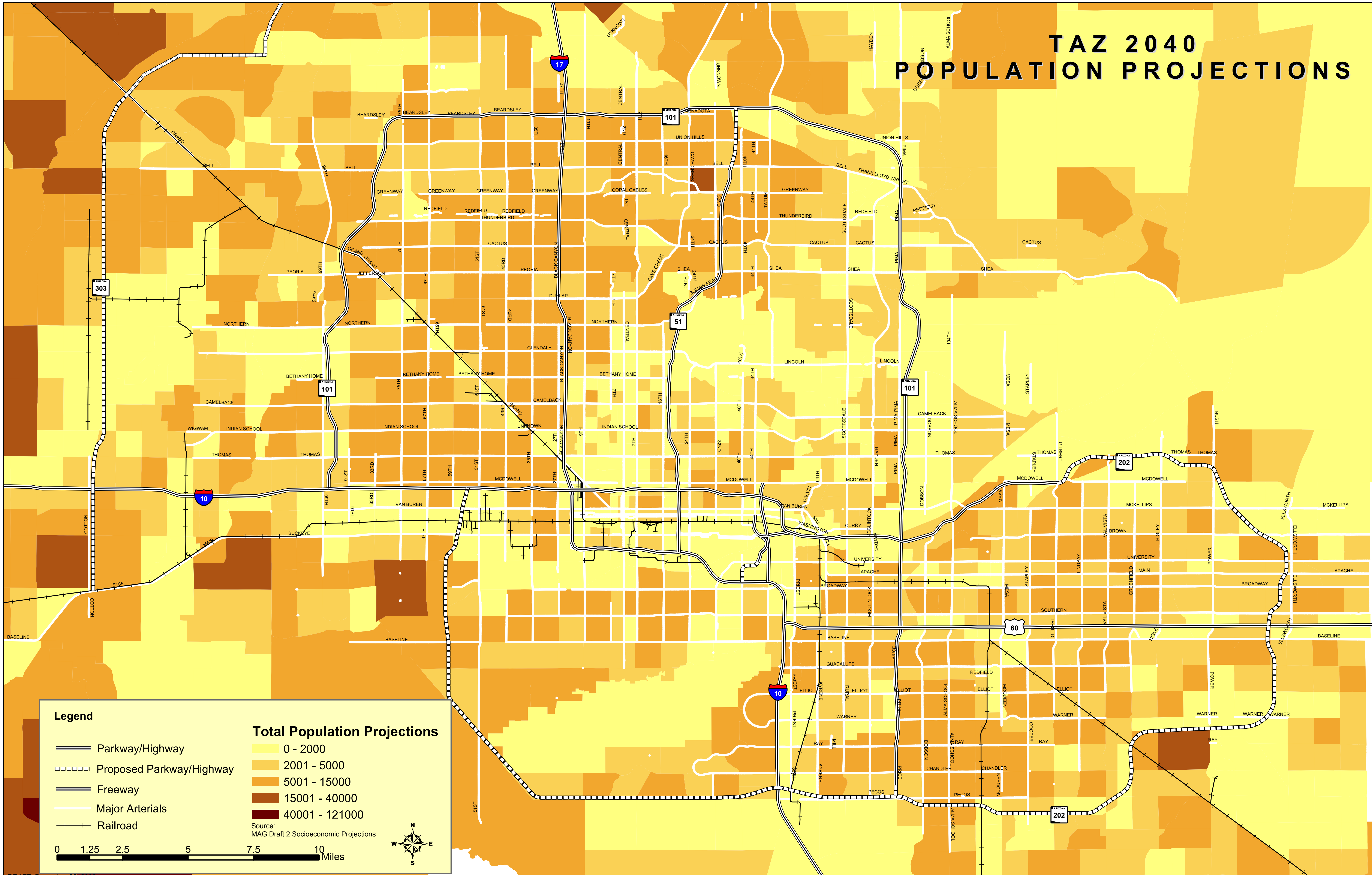
Exhibits 5.1-1 and 5.1-2 illustrate the change in the projected population and employment in each city between the previous regionally adopted population estimates and the revised draft estimates. Exhibit 5.1-3 illustrates the difference in the population levels between 2000 and 2040 by Traffic Analysis Zone (TAZ).



2040 POPULATIONS PROJECTIONS
BY YEAR AND CITY
Peoria
2000 Pop. Proj. 267296
2002 Pop. Proj. 383513
Surprise
2000 Pop. Proj. 161983
2002 Pop. Proj. 644386
Maricopa County
2000 Pop. Proj. 223306
2002 Pop. Proj. 615477
Fountain Hills
2000 Pop. Proj. 55728
2002 Pop. Proj. 31527
Scottsdale
2000 Pop. Proj. 387162
2002 Pop. Proj. 301621
El Mirage
2000 Pop. Proj. 14284
2002 Pop. Proj. 51364
Youngtown
2000 Pop. Proj. 4978
2002 Pop. Proj. 7344
Glendale
2000 Pop. Proj. 346344
2002 Pop. Proj. 313430
Litchfield Park
2000 Pop. Proj. 15688
2002 Pop. Proj. 14807
Phoenix
2000 Pop. Proj. 2487026
2002 Pop. Proj. 2261117
Paradise Valley
2000 Pop. Proj. 15752
2002 Pop. Proj. 16170
SRPMIC
2000 Pop. Proj. 9728
2002 Pop. Proj. 7529
Buckeye
2000 Pop. Proj. 212486
2002 Pop. Proj. 586782
Tolleson
2000 Pop. Proj. 11056
2002 Pop. Proj. 6355
Mesa
2000 Pop. Proj. 693031
2002 Pop. Proj. 649011
Tempe
2000 Pop. Proj. 194164
2002 Pop. Proj. 187227
Goodyear
2000 Pop. Proj. 264382
2002 Pop. Proj. 366203
Avondale
2000 Pop. Proj. 124899
2002 Pop. Proj. 114840
Guadalupe
2000 Pop. Proj. 5991
2002 Pop. Proj. 5305
Gilbert
2000 Pop. Proj. 329341
2002 Pop. Proj. 287760
Chandler
2000 Pop. Proj. 313060
2002 Pop. Proj. 289944
GRIC
2000 Pop. Proj. 3482
2002 Pop. Proj. 9479
Queen Creek
2000 Pop. Proj. 106331
2002 Pop. Proj. 93606
17
101
303
51
101
101
202
10
60
10
202
Legend
Freeway
Proposed Parkway/Highway
Major Arterials
Railroad
2040 Population Projection in 2000
2040 Population Projection in 2002
Source:
MAG Draft 1 and Draft 2 Socioeconomic Projections
0 1.25 2.5 5 7.5 10 Miles
N
W E
S
DRAFT: December 26, 2002



DRAFT: December 26, 2002


TAZ 2040
POPULATION PROJECTIONS
Legend
Parkway/Highway
Proposed Parkway/Highway
Freeway
Major Arterials
Railroad
Total Population Projections
0 - 2000
2001 - 5000
5001 - 15000
15001 - 40000
40001 - 121000
Source:
MAG Draft 2 Socioeconomic Projections
0 1.25 2.5 5 7.5 10 Miles
N
W
E
S
DRAFT: December 26, 2002

These new draft population projections have resulted in changes to the ridership projections in each of the high capacity corridors selected as part of the evaluation process in Milestone 4. Sections 5.1.1 and 5.1.2 outline the effects of these revised projections on the ridership and cost estimates for the LRT/Dedicated BRT corridors and the commuter rail corridors. A revised analysis of cost effectiveness has also been performed to account for the new ridership and costs. This revised analysis is presented in Section 5.1-3.

Cost estimates have been revised for all four commuter rail corridors and the LRT/Dedicated BRT corridors included in Groups A and B from Milestone 4. The commuter rail discussion below outlines several alternatives for service operation including the use of operating windows, use of diesel multiple unit trains (DMU), and alternative service plans. LRT/BRT costs have been modified to reflect consolidations of portions of selected corridors and slight modifications to the alignments of other corridors.

5.1.1 Commuter Rail Revised Cost and Ridership

Four freight rail corridors were identified in the MAG region as potential commuter rail corridors:

- Burlington Northern Santa Fe (BNSF) – downtown Phoenix to Surprise *(potential extension to Wickenburg)*
- Union Pacific Mainline/Chandler – downtown Phoenix to Chandler
- Union Pacific Southeast – downtown Phoenix to Queen Creek
- Union Pacific Yuma – downtown Phoenix to Buckeye *(potential extension to Palo Verde Nuclear Generating Station)*

Three phases of service were developed for the implementation of commuter rail service in the MAG region. The objective of phased implementation is to spread the capital costs for implementing service over a period of years to allow for ridership growth. The characteristics of the three phases of service are:

- Phase 1: Start-up. This service involves limited peak-period service consisting of 3 trains inbound in the a.m. peak and 3 trains outbound in the p.m. peak. Span of service would likely be 6 hours (3 hours in a.m. peak, 3 hours in p.m. peak).
- Phase 2: Intermediate. This stage represents an increase in service to 6 trains inbound in the a.m. peak and 6 outbound in the p.m. peak. Counter flow service of one train per hour would be provided during morning and afternoon peaks. Off-peak service would consist of hourly

service during the midday and evening. Span of service would be about 15 hours (6 a.m. to 9 p.m.).

- Phase 3: Full Operation. The final phase consists of 12 trains running inbound during the a.m. peak and outbound during p.m. peak with 15 minute headways. Counter flow peak period service would be provided every 30 minutes. Off-peak trains would run every 30 minutes. Span of service would be 18 hours (5 a.m. to 11 p.m.).

Daily boarding estimates for each of these corridors were developed in conjunction with capital and operating costs. The four corridors were also evaluated along with the remaining 24 potential high capacity transit corridors using several evaluation criteria including socio-economic data, cost, ridership, and cost effectiveness.

Based upon the results of the capital cost estimates and discussions with representatives from BSNF and UP, it was determined that only the Phase 1 and Phase 3 levels of service would be carried forward for further evaluation. Phase 1 service represents the minimum amount of service needed to be provided to operate a potential viable commuter rail service, with three trains operating during the peak commute. Phase 3 service would be the ultimate operation of commuter rail service which would provide residents of the MAG region with a true "turn up and go" service providing frequent and reliable service throughout the day during both peak and off-peak commute times. Phase 2 (Intermediate Service) is not being specifically evaluated in the portion of the report. Instead this service will be addressed during the discussion of phasing and implementation in Section 5.3.

The assessment of commuter rail in the MAG region performed as part of Milestone 4 indicates that, in terms of ridership, the lines would perform on par with recent commuter rail systems in the West. However, there are significant challenges to implementing commuter rail in the MAG region in terms of cost. The rail corridors in the MAG region have been optimized over the years for the service they provide today – a local-serving freight operation. As a result, projections twenty or more years into the future looking at a fully mature commuter rail service would require significant upgrades with a second track, centralized traffic control and other necessities for a safe and reliable mature system. This requires a significant investment in rail infrastructure, on par with projected costs for the BRT and LRT systems also under evaluation.

Nevertheless, two factors were recognized in Milestone 4. First, while cost-effectiveness is extremely important from both a "good planning" perspective and its match with Federal funding criteria, other factors must also be considered, such as the need for good regional connectivity. Second, it is possible that a more modest "start-up" operation featuring a more focused peak-only service and/or smaller, more maneuverable diesel multiple unit (DMU) trains could be implemented with fewer capital investments, thus improving short-term cost-effectiveness. While this does not change conclusions about investments that would be required in the long-term for an "ultimate" commuter rail system, a start-up service can nevertheless provide significant benefits in a short-term horizon.

Several of the data input assumptions for commuter rail service have been adjusted for Milestone 5 in light of the revised population projections and input from the Agency Working Group. Table 5.1-1 summarizes the refinements made to the commuter rail assumptions for Milestone 5.

Table 5.1-1 **Refined Commuter Rail Assumptions**

Data Input	MS 4 Assumption	MS 5 Revised Assumptions
Population Projection (2040)	Adopted population projections for the MAG region with a 2040 build out population of 6.4 million residents.	Updated population projections for the MAG region with a Socioeconomic Draft 2 2040 projected build out population of 7.4 million residents.
Stations	BNSF 6 stations.	BNSF 7 stations (additional Surprise station at Loop 303) All other corridors the same.
Station Catchment Area	3 mile primary catchment (secondary catchment to 5 miles).	3 miles primary, out to 10 miles for secondary catchment.
Costs	No change, however revisions were made between MS 4 drafts to refine some unit costs and the number of vehicles required.	Same as revised MS 4 but with more vehicles and parking spaces. Additional refinements to unit costs were also made.
Commute	No reverse commute.	Reverse commute assumed on all corridors.

There are several options in terms of operating windows, technology, and operating characteristics which could change the cost-effectiveness of commuter rail. In addition, the new draft population projections have resulted in revised ridership forecasts for the commuter rail corridors. A more refined view of commuter rail has therefore been undertaken in order to potentially identify strategies to reduce the capital and/or operating costs along one or more of the four possible corridors. The preliminary results of these strategies are presented below.

Revised Commuter Rail Ridership Forecasts

Commuter rail forecasts have been developed using a direct demand modeling (DDM) approach. This model was the same one used in the

Milestone 4 report. A detailed description of the DDM methodology is contained in the Milestone 4 report. The discussion is this report focuses on specific adjustments and refinements made to the model input factors and methodology, resulting from new population projections and comments from local agencies.

The DDM approach projects the number of weekday boarding passengers at proposed commuter rail stations using the population within station 'catchment' areas, factored according to the level of service (e.g. number of peak period trains, off peak service, time savings, etc). Total corridor demand was simply the sum of boarding passengers for all stations within the corridor. In Milestone 4 certain stations were defined as 'destination' stations and no boarding passengers were assumed to board here for the outward leg of the trip.

Three refinements have subsequently been made to the methodology for the updated forecasts:

- Adjustment of catchment areas.
- Inclusion of 'destination' stations and 'counter-peak' (reverse) commute.
- Use of Year 2020 MAG Draft 2 population projections for Phase 1 ridership and costs.

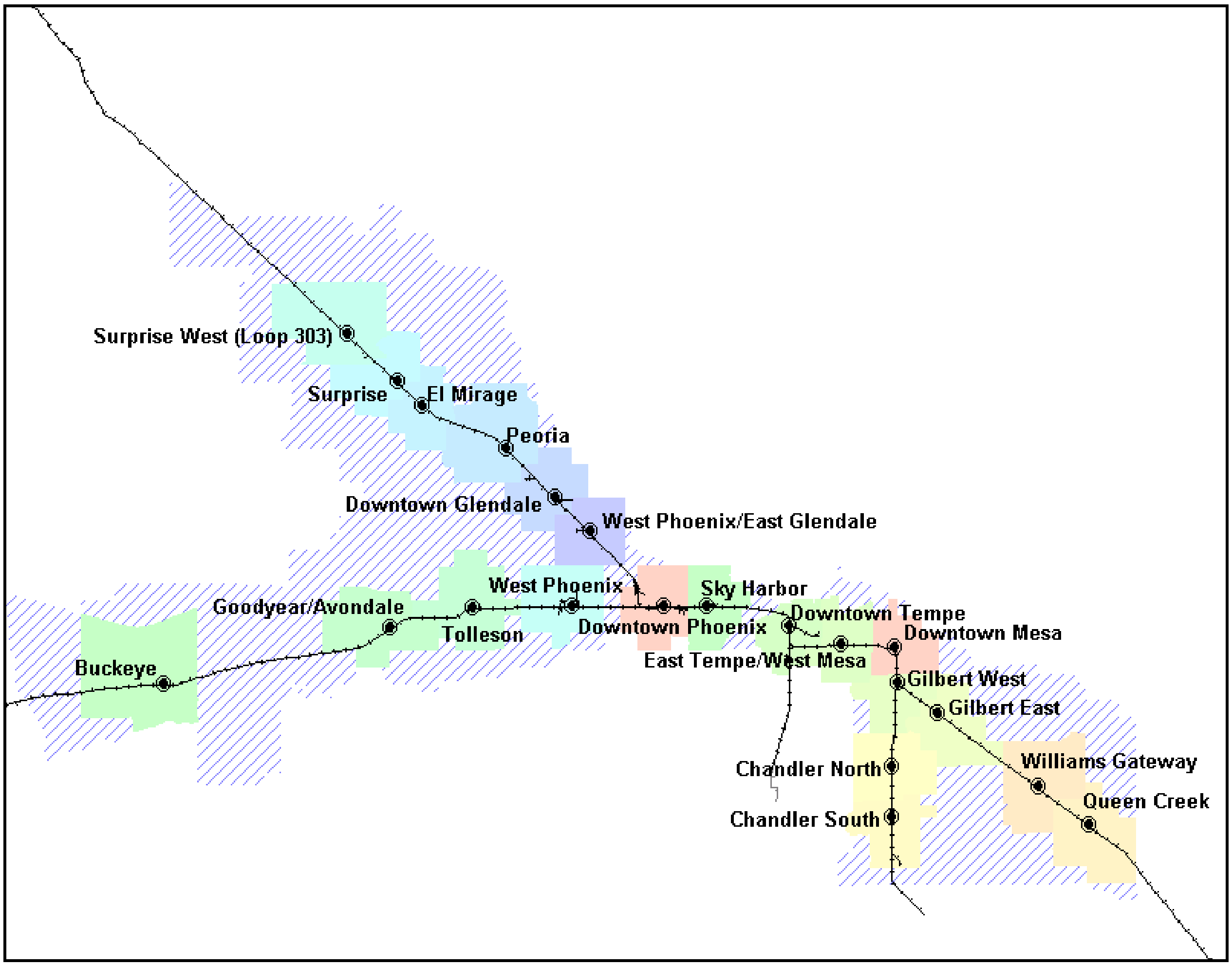
Input assumptions have also been modified (e.g. station location) with the most significant being the inclusion of new draft population and employment projections.

Adjusted Catchments

Catchment areas for Milestone 4 were developed from an initial three-mile radius that was based on observations of the GO Transit commuter rail system in Toronto. Adjustments were then made based on professional judgment to include likely areas of potential riders located just outside the three mile radius. While it was recognized that commuter rail trips would be made from outside these catchment areas, it was considered that the bulk of trips would be accounted for with this area. Catchment areas have now been refined to better represent trips from more distant origins as it was noted that particular stations such as Buckeye had large populations just outside the primary catchment, and this could lead to understatement of ridership.

Consequently explicit 'secondary catchments' have been incorporated into the methodology, a concept that has also been used in the GO Transit DDM. They represent areas outside the immediate 'primary' catchment area but from which commuter rail trips are still made. These areas were defined based on observations of maximum driving distance in the GO Transit area, with radii of 10 miles or more in the outer areas (i.e. around 7 miles outside the primary catchment) while much reduced in the central areas. Primary catchments were also modified during this process where areas could now be better represented as secondary rather than primary catchments. Exhibit 5.1-4 below shows the new catchment definitions where primary catchments are represented with solid shading and secondary catchments are represented with hatched shading. Note 'destination' stations are also included, which is discussed in more detail later in this section.

Exhibit 5.1-4: Station Catchment Areas



Passenger forecasts from secondary areas are projected in a similar manner to those from the original primary catchment areas: ridership is calculated as a trip rate dependent on the level of service, multiplied by the catchment population. However, level of service for secondary catchments is related to distance from the station rather than train frequency, and the basic trip rate is lower.

The forecasting process is described in more detail in Milestone 4. The basic steps are described below and the factors included in the following tables. The tables also indicate any differences between the handling of primary and secondary catchments.

The initial trip rate is based on the number of peak period trains from primary catchment areas, and a lower generic trip rate for secondary catchment areas.

Table 5.1-2 **Peak Train Service Trip Rates**

Catchment Type	Peak period trains	Boardings/1000 population
Secondary	All	3
Primary	1	9
	2	14
	3	17
	4	19.5
	5	22.5
	6	25
	7	27
	8	28
	9	28
	10	28
	11	28
	12	28

A factor is then applied to primary catchment trip rates to account for the availability or not of an off-peak service:

Table 5.1-3 **Off Peak Service Factors**

Catchment Type	Off peak service	Factor
Secondary	All	1
Primary	Yes	1.4
	No	0.82

For secondary catchment trips only, a factor is applied depending on the straight-line distance to the station. Trip rates in the outer half of the secondary catchment are thus half those in the inner portion.

Table 5.1-4 **Distance from Station Factors**

Catchment Type	Distance to nearest station (miles)	Factor
Secondary	0-6	1
	>6	0.5
Primary	All	1

Time saving factors are then applied to both secondary and primary catchment trip rates.

Table 5.1-5 **Time Saving Factors**

Timesaving (minutes)	Factor
0-15	0.3
15-30	0.44
30-45	0.9
45-60	0.95
> 60	1.15

A final factor relates general effects of the distance from the station to the downtown, including availability of alternatives, reliability improvements and significance of comfort. This is applied to both primary and secondary catchment trip rates.

Table 5.1-6 **Downtown Distance Factors**

Distance from Downtown (miles)	Factor
0-5	0.3
5-8	0.5
8-15	0.8
> 15	1

The total number of boarding passengers is determined as the sum of both the primary and secondary catchment areas for each station. Consequently, corridor demand is determined by summing ridership for all stations in the corridor.

Destination Stations

Destination stations were not included in the Milestone 4 ridership methodology as it was assumed that the total corridor ridership could be accounted for by inclusion of 'origin' stations only, with reverse peak trips implicit. The new forecasts also include trips from these 'destination stations', as it has been suggested that ridership may be understated without them.

Ridership from destination stations was determined in a similar way to the origin stations. 'Reverse peak direction' passenger forecasts were determined for the three Phases with the respective counter-peak level of service assumed shown in Exhibit below.

Table 5.1-7 **'Reverse Peak Direction' Train Frequency**

Development Phase	Peak Period Trains	Off Peak Service
1: Introductory Service	0	No
3: Full commuter rail operation	6	Yes

Trips in the counter-peak service are likely to experience significantly less congestion than with-peak highway trips, and hence distance and time factors for the "less than 5 mile" distance band were used for all destination stations. A further factor of 0.5 was applied to account for the relative dispersal of employment sites in outer areas, compared to within the downtown area. It is based on the approximate directionality of trips (inbound and outbound) in the MAG model trip matrix.

For the BNSF and UP Yuma corridors, the only change from Milestone 4 is the inclusion of counter-peak passengers from downtown Phoenix. For the UP Southeast and UP Mainline/Chandler corridors on the other hand, several destination stations are now included: Sky Harbor, downtown Tempe, downtown Mesa as well as downtown Phoenix. In particular, the destination stations east of downtown Phoenix provide the opportunity for trips in two directions. In these cases the MAG model trip matrix was used to give approximate directionality of trips in the corridor at these stations. Catchment population was divided in proportion to the two directions, inbound and outbound, and the level of service factors applied to each direction separately. Bi-directional forecasts were also developed for East Tempe, since it lies within the same central area as the other destination stations. Reverse peak ridership is less significant for the outer stations, and so may be considered implicit in the ridership figures as before. Table

5.1-8 summarizes these refinements made to the ridership demand assumptions. On average, these refinements resulted in a 10 percent ridership increase in each corridor using the population forecasts in Milestone 4.

Table 5.1-8 **Refined Ridership Demand Assumptions**

Corridor	Revised Assumptions
BNSF	• Additional station at Grand, Loop 303. • Reverse commute service.
UP Mainline/Chandler	• Reverse commute service. • Specific origin ridership demand generated at destination stations.
UP Southeast	• Reverse commute service. • Specific origin ridership demand generated at destination stations.
UP Yuma	• Reverse commute service.

New Population Projections

The largest change from the Milestone 4 forecasts is input data from the new Draft 2 socioeconomic population projections. These suggest higher overall growth, with total population around 15 percent higher than previously forecast. The distribution of growth is also different, with much higher rates in the West Valley area, while growth is reduced in the central and East Valley areas. Exhibit 5.1-1 on page 2 shows the change in population projections between those used in Milestone 4 and those used here in Milestone 5. Several major changes have resulted from the new draft forecasts that have a major impact upon commuter rail boarding projections. The changes noted below are a percentage change from the previous regionally adopted forecasts:

- Buckeye population increase of 276 percent
- Surprise population increase of 298 percent
- El Mirage population increased by 260 percent
- Mesa population reduced 6.4 percent
- Queen Creek population reduced 12 percent
- Gilbert population reduced 13 percent
- Chandler population reduced by 7.5 percent

The changes in population projections have been incorporated in the latest commuter rail ridership forecasts. Table 5.1-9 below summarizes the updated forecasts and the percentage change from those provided in Milestone 4. Table 5.1-10 summarizes the total ridership in each corridor. This figure is obtained by doubling the boarding total at each station to account for return trips.

The action of adjusting Phase 1 ridership estimates to the Year 2020 does lower the projected ridership in each corridor, as a result of the lowered overall population levels in 2020 when compared to 2040. This also impacts the cost estimates for Phase 1 service by lowering the expected initial costs as a result of the need for fewer vehicles and station parking facilities. These refined ridership figures have no effect upon the cost of implementing and operating the Ultimate (Phase 3) level of service. Instead, this is a minor change to the estimated *initial* cost of implementing commuter rail service. This modification was made to present a more accurate forecast of ridership and costs based upon a more likely horizon year for implementing Phase 1 commuter rail service.

Table 5.1-9 **Commuter Rail Station Boarding Forecasts and Comparison with Milestone 4**

Station	Location	Total Boardings		Percent Change from Milestone 4	
		Initial (Phase 1) 2020	Ultimate (Phase 3) 2040	Initial (Phase 1) 2040	Ultimate (Phase 3) 2040
BNSF					
Downtown Phoenix	Central Avenue	-	136	n/a	n/a
West Phoenix/East Glendale	Camelback/43rd Ave	265	734	3%	2%
Glendale	Glendale/59th Ave	416	1,123	116%	108%
Peoria	83rd Avenue	433	1,185	51%	47%
El Mirage	Grand/Santa Fe	460	1,243	115%	107%
South Surprise	Grand/Bell	455	1,245	1%	-2%
North Surprise	Grand/Loop 303	402	2,406	n/a	n/a
UP Mainline/Chandler					
Downtown Phoenix	Central Avenue	-	136	n/a	n/a
Sky Harbor	24th Street	32	166	n/a	n/a
Downtown Tempe	Tempe Depot	32	157	n/a	n/a
East Tempe	Loop 101	84	266	-2%	6%
Downtown Mesa	Mesa Depot	41	239	n/a	n/a
Gilbert	Baseline Road	71	197	-15%	-15%
North Chandler	Chandler/Arizona	232	656	-1%	-1%
South Chandler	Queen Creek Road	194	463	3%	-12%

Station	Location	Total Boardings		Percent Change from Milestone 4	
		Initial (Phase 1) 2020	Ultimate (Phase 3) 2040	Initial (Phase 1) 2040	Ultimate (Phase 3) 2040
UP Southeast					
Downtown Phoenix	Central Avenue	-	136	n/a	n/a
Sky Harbor	24th Street	32	166	n/a	n/a
Downtown Tempe	Tempe Depot	32	157	n/a	n/a
East Tempe	Loop 101	84	266	-2%	6%
Downtown Mesa	Mesa Depot	41	239	n/a	n/a
Gilbert	Gilbert Road	208	534	5%	-5%
Williams Gateway	Williams Field	295	797	-23%	-26%
Queen Creek	Ellsworth Avenue	292	941	-54%	-39%
UP Yuma					
Downtown Phoenix	Central Avenue	-	136	n/a	n/a
West Phoenix	51st Avenue	250	685	55%	52%
Tolleson	99th Avenue	284	922	-19%	-6%
Goodyear	Main/Litchfield	475	1,446	-18%	-11%
Buckeye	Baseline/Miller	347	2,827	425%	1,428%

Table 5.1-10 **Commuter Rail Total Ridership Forecasts and Comparison with Milestone 4**

Corridor	Total Boardings		Percent Change from Milestone 4	
	Initial (Phase 1) 2020	Ultimate (Phase 3) 2040	Initial (Phase 1) 2040	Ultimate (Phase 3) 2040
BNSF	4,862	16,145	70%	101%
UP Chandler/Mainline	1,372	4,561	15%	36%
UP Southeast	1,970	6,471	-19%	-5%
UP Yuma	2,710	12,034	17%	85%

Particular stations achieving much higher ridership than projected for Milestone 4 include Buckeye, Glendale and El Mirage, mainly due to the revised population projections. Ridership forecasts from Buckeye in particular are much higher than those developed previously as they combine a substantial increase in local population (the additional Buckeye population is mainly within the Buckeye station catchment) with the addition of secondary catchment trips. As secondary trips are not modeled to be sensitive to train frequency, the additional trips from some stations are reduced from the Ultimate service when compared to Milestone 4. This is particularly the case where some areas were previously included within a primary catchment and have now been reassigned to a secondary catchment. Stations with somewhat reduced ridership compared to Milestone 4 include Queen Creek and Williams Gateway. This illustrates the reduced population projections for these areas.

The new station at Loop 303, the substantial increase in populations of Surprise, El Mirage and the inclusion of secondary trips leads to BNSF ridership increasing by more than 80% for the initial service, reducing to 64% for the Ultimate service due to the insensitivity of secondary catchment trips to train frequency. Likewise, the substantial increase in population of Buckeye and revised catchments cause a doubling of ridership in the UP Yuma corridor for the initial service, with around 85% more trips for the Ultimate service. The effect is especially great as much of the population growth in these two corridors occurs in the outer areas - the most conducive to commuter rail. For the UP Southeast corridor, the increases in ridership generated by the inclusion of "destination" stations and secondary catchments are more than offset by the reduction in the population projections, and ridership is now 5%-8% lower than that developed for Milestone 4.

Despite these large changes, the comparative strength between corridors in terms of ridership remains the same as Milestone 4. BNSF continues to achieve the highest ridership, followed by UP Yuma. The UP Southeast and Mainline/Chandler corridors achieved the weakest ridership in Milestone 4, and the changes in population in this area have further exacerbated this. As stated in Milestone 4, however, these forecasts include no network interactions, and this shall next be incorporated through the use of the MAG four-stage model for the final report.

Revised Commuter Rail Capital and Operating Costs

Capital and operating cost estimates have been revised for each of the four commuter rail corridors for both the Phase 1 (Start-Up) and Phase 3 (Full Service) levels of service. Adjustments have been made to the cost estimates to include additional passenger vehicles and station parking to accommodate additional forecasted ridership on the UP Yuma and BNSF lines. Revisions have been made to the length of the UP Southeast and BNSF lines to more accurately reflect the true distances of these corridors. Finally, an additional station has been added to the BNSF line at Loop 303 and Grand Avenue to accommodate the population growth projected for in the City of Surprise.

RECOMMENDED COMMUTER RAIL
BNSF
UP Yuma
UP Southeast
Legend
Parkway/Highway
Proposed Parkway/Highway
Freeway
Major Arterials
Commuter Rail
Proposed Express BRT
CP/EV LRT
BRT Central Ave
Existing Express BRT
0 1.5 3 6 9 12 Miles
N
W
E
S
November 5, 2002

Commuter Rail Capital Costs

The primary change to the capital cost estimates involves the need for additional vehicles and parking at stations along the UP Yuma and BNSF corridors to accommodate the larger number of forecasted riders. The same rail infrastructure requirements in respect to tracks and signaling assumed in Milestone 4 are assumed in these estimates. Minor modifications have also been made to the UP Southeast and UP Mainline/Chandler corridors to revise the number of vehicles required for Phase 3 service. Modified phasing in of Phase 3 service would allow for a lower vehicle requirement. As noted above capital costs for Phase 1 service are based upon ridership levels estimated for the Year 2020. This modification has had no effect upon the overall capital cost for implementing the Ultimate (Phase 3) level of service. Additional refinements have been made to costs concerning the maintenance and storage facilities since the initial draft of Milestone 5. These changes have resulted in slight reductions in Phase 3 capital costs (less than 5 percent). Due to the nature of the Benefit Cost analysis, these changes have not been incorporated. However, the minimal change in cost does not have a profound effect on the results of this analysis.

Table 5.1-11 compares the capital costs presented in Milestone 4 and revised capital costs for each corridor. The costs for the Startup and Full Service phases are both included in this table. Additional detail for the revised commuter rail capital costs is provided in Table 5.1-12.

Table 5.1-11 **Commuter Rail Capital Cost Comparison**

Commuter Rail Corridor	Previous (Milestone 4) Capital Costs ($ millions)	Revised Capital Costs ($ millions)	Change in Capital Cost (MS 4 to MS 5)
BNSF Phase 1	$289.39	$292.30	$2.91
BNSF Phase 3	$360.40	$445.63	$85.23
BNSF Total	$649.79	$737.93	$88.14
UP Mainline/Chandler Phase 1	$273.87	$269.93	-$3.94
UP Mainline/Chandler Phase 3	$265.41	$260.29	-$5.12
UP Mainline/Chandler Total	$539.29	$530.22	-$9.07
UP Southeast Phase 1	$295.88	$270.34	-$25.54
UP Southeast Phase 3	$348.66	$297.15	-$51.51
UP Southeast Total	$644.54	$567.50	-$77.04
UP Yuma Phase 1	$141.58	$143.25	$1.67
UP Yuma Phase 3	$268.10	$308.55	$40.45
UP Yuma Total	$409.68	$451.80	$42.12

Note: Phase 3 costs under Milestone 4 represent the costs of implementing both Phase 2 (Intermediate) and Phase 3 (Full Service) commuter rail operations.

Table 5.1-12	Revised Commuter Rail Capital Cost Summary

Item			BNSF Phase 1	BNSF Phase 3	UP Mainline/ Chandler Phase 1	UP Mainline/ Chandler Phase 3	UP Southeast Phase 1	UP Southeast Phase 3	UP Yuma Phase 1	UP Yuma Phase 3
Corridor Length (miles)			27.73	27.73	27.95	27.95	36.18	36.18	32.5	32.5
Subtotal-Civil			$12,072,304	$198,400	$23,106,160	$188,890	$24,829,520	$334,500	$1,250,000	$1,914,000
Subtotal-Utilities			$23,138,016	$3,273,600	$13,024,440	$3,116,685	$13,024,440	$903,150	$0	$1,742,400
Subtotal-Track			$33,332,994	$6,658,195	$28,200,799	$4,666,366	$19,695,628	$7,511,088	$0	$2,460,880
Subtotal-Stations			$30,382,000	$15,414,000	$31,280,000	$3,570,000	$31,518,000	$5,124,000	$24,066,000	$11,760,000
Subtotal-Controls & Signals			$0	$28,269,856	$15,785,584	$10,908,972	$15,585,584	$18,905,720	$0	$28,454,896
Subtotal Facilities			$2,620,000	$22,000,000	$2,800,000	$15,000,000	$3,620,000	$17,000,000	$3,090,000	$20,000,000
A. Construction Subtotal			**$101,545,314**	**$75,814,051**	**$114,196,983**	**$37,450,913**	**$108,273,172**	**$49,778,458**	**$28,406,000**	**$66,332,176**
Environmental Mitigation	Percent of A	2%	$2,030,906	$1,516,281	$2,283,940	$749,018	$2,165,463	$995,569	$568,120	$1,326,644
B. Construction Cost Subtotal			**$103,576,220**	**$77,330,332**	**$116,480,923**	**$38,199,931**	**$110,438,635**	**$50,774,027**	**$28,974,120**	**$67,658,820**
C. Right of Way Subtotal			**$10,802,875**	**$128,424,550**	**$6,969,600**	**$66,536,800**	**$7,715,325**	**$73,539,500**	**$10,637,350**	**$58,318,125**
D. Vehicles Subtotal			**$76,945,000**	**$85,450,000**	**$46,587,500**	**$70,050,000**	**$54,167,500**	**$73,305,019**	**$60,525,000**	**$78,600,000**
Cost Contingencies (Uncertainties, Changes)										
Design&Construction	Percent of B	25%	$25,894,055	$19,332,583	$29,120,231	$9,549,983	$27,609,659	$12,693,507	$7,243,530	$16,914,705
Right of Way	Percent of C	30%	$3,240,863	$38,527,365	$2,090,880	$19,961,040	$2,314,598	$22,061,850	$3,191,205	$17,495,438
Vehicle Cost	Percent of D	10%	$7,694,500	$8,545,000	$4,658,750	$7,005,000	$5,416,750	$7,330,502	$6,052,500	$7,860,000
Program Implementation (Agency Costs and Fees)										
Design&Construction	Percent of B	31%	$32,108,628	$23,972,403	$36,109,086	$11,841,979	$34,235,977	$15,739,948	$8,981,977	$20,974,234
Right of Way Purchase	Percent of C	15%	$1,620,431	$19,263,683	$1,045,440	$9,980,520	$1,157,299	$11,030,925	$1,595,603	$8,747,719
Vehicle Procurement	Percent of D	5%	$3,847,250	$4,272,500	$2,329,375	$3,502,500	$2,708,375	$3,665,251	$3,026,250	$3,930,000
E. Capital Cost Subtotal			**$265,729,823**	**$405,118,415**	**$245,391,784**	**$236,627,752**	**$245,764,118**	**$270,140,528**	**$130,227,535**	**$280,499,040**
Project Reserve	Percent of E	10%	$26,572,982	$40,511,842	$24,539,178	$23,662,775	$24,576,412	$27,014,053	$13,022,753	$28,049,904
F. Total Capital Cost			**$292,302,805**	**$445,630,257**	**$269,930,963**	**$260,290,528**	**$270,340,529**	**$297,154,581**	**$143,250,288**	**$308,548,944**
			Total all 3 Phases	**$737,933,062**	**Total all 3 Phases**	**$530,221,490**	**Total all 3 Phases**	**$567,495,110**	**Total all 3 Phases**	**$451,799,232**

Note: All costs are in 2001 dollars. More detailed information on costs can be found in Appendix A.

Cost categories in Table 5.1-12 include:

- **Civil** – This category includes sound walls, grade separations, grade crossings, bridges, and earthwork (grading, etc).
- **Utilities** – This is an estimate for relocating utilities both overhead and underground along the alignment. Utilities can include power lines, underground pipes and fuel lines, sewer lines, etc.
- **Track** – This category presents the costs for installing new trackwork in the corridor.
- **Stations** – The cost of implementing the commuter rail stations, including associated parking, is included here. For the purposes of this cost estimate parking was distributed as 80 percent surface parking and 20 percent structured parking.
- **Controls and Signals** – The category identifies the costs for installing Centralized Traffic Control signals in the corridor to manage train operations.
- **Facilities** – The cost of the maintenance and storage facility and an operations control and dispatching center are estimated here. The maintenance and storage facility has been scaled to accommodate only the number of trainsets required to provide service in each corridor, allowing for an equal analysis of each corridor based upon its individual needs.
- **Environmental Mitigation –** This is a cost allowance added to the construction costs identified above which would be used to provide spot mitigation measures such as landscaping that could be identified later in the implementation process. This figure has been reduced to two percent (2%) of the construction cost.
- **Construction Add-ons** – A cost contingency of 25 percent is added to the construction cost estimate to allow for variations in unit costs and unforeseen design issues that may arise during the development of the project. A program implementation cost of 31 percent is also added to account for the cost of designing and constructing the system.
- **Right-of-Way** – This category includes the land required to accommodate the system. Right-of-way costs assume the cost of purchasing a large enough portion of the railroad right-of-way to accommodate the implementation of a new main track for commuter rail operations on the BNSF and UP Southeast corridors. The rate applied for this cost represents an average of right-of-way costs paid by four public agencies during the past decade (Los Angeles - Metrolink, San Diego - North County Transit District, Miami - Tri-Rail, and Salt Lake City - Utah Transit Authority) for freight rail rights of way.

Specific right-of-way costs would be determined through negotiations with the freight railroad operators and could vary dramatically from the experience of other public agencies in the United States. The cost estimate also includes the cost of right-of-way for stations and parking lots.

- **Right-of-Way Add-ons** – A cost contingency of 30 percent has been added to right-of-way, similar to the contingency for construction. This contingency accounts for increased land costs and possible increases in land purchases. The right-of-way procurement process is accounted for in the 15 percent contingency.
- **Vehicles/Maintenance of Way** – This category includes the commuter rail passenger cars and locomotives, spare parts, and maintenance of way equipment. The number of vehicles estimated for service in each commuter rail corridor is designed to provide a seat to each passenger. Individual vehicle capacity in this case is approximately 135 passengers. The overall capacity of each commuter rail vehicle with standing passengers is substantially more, approximately 300 passenger per vehicle. Should a policy decision be made closer to possible commuter rail service implementation about allowing standing passengers, the number of vehicles required to operate service in corridor could be reduced; therefore reducing the capital investment cost and the annual operating and maintenance costs.
- **Vehicle Add-ons** – These include contingencies for the price of the commuter rail vehicles, and the cost of the procurement, testing, and commissioning of the vehicles.

<u>Commuter Rail Operating and Maintenance Costs</u>

Operating and maintenance costs for commuter rail service were estimated using the same method as in Milestone 4. Year 2001 bus and commuter rail operating costs from three other commuter rail operators were used as a basis for estimating the likely annual cost of operating commuter rail service in the MAG region. This does represent a change from Milestone 4 when four operators were used. The Seattle Sounder system was removed because of the large discrepancy between this system's cost and the cost of the remaining three systems. The three commuter rail operators are:

- Dallas Area Rapid Transit Authority (DART) – Dallas Trinity Railway Express
- North County Transit District (NCTD) – San Diego Coaster
- Altamont Commuter Express (ACE)/Valley Transit Authority (VTA) – San Jose Altamont Commuter Express

Additional detail on the assumptions for estimating operating and maintenance costs can be found in Section 4.1 of the Milestone 4 report.

Operating costs in Phase 1 include the cost of lease access rights to the corridor, even in corridors where a second main track is constructed. In this case, the freight railroad operators still own the underlying right-of-way and would likely charge for commuter rail use of their property. In Phase 3, it is assumed that the commuter rail operator will purchase a portion of the right-of-way where a second main track exists, so lease costs are only included in single track portions of the corridors.

Adjustments have been made to the operating costs to reflect the different sized trains required on the routes to accommodate the new forecasted ridership. Table 5.1-13 presents operating and maintenance costs estimates from Milestone 4 for reference along with the revised cost estimates.

Table 5.1-13 **Commuter Rail Operating Cost Comparison**

Commuter Rail Corridor	Previous (Milestone 4) Annual O&M Cost ($ millions)	Revised Annual O&M Cost ($ millions)	Change in O&M Cost (MS 4 to MS 5)
BNSF Phase 1	$3.45	$4.90	$1.45
BNSF Phase 3	$18.25	$22.55	$4.30
UP Mainline/Chandler Phase 1	$2.00	$1.85	-$0.15
UP Mainline/Chandler Phase 3	$14.05	$14.05	$0.00
UP Southeast Phase 1	$4.65	$3.05	-$1.60
UP Southeast Phase 3	$21.60	$16.1	-$5.50
UP Yuma Phase 1	$2.80	$3.60	$0.80
UP Yuma Phase 3	$19.95	$22.40	$2.45

Alternative Commuter Rail Operating Scenarios

As result of the results of Milestone 4 and the possible impediments to implementation caused by the large amount of capital infrastructure required to implement commuter rail in several of the freight railroad corridors, a series of alternatives were identified to explore more cost-effective ways of implementing commuter rail service in the MAG region. These options include variations of ownership of the freight corridor, the utilization of operating windows, exploration into the use of diesel multiple unit trains, and modifications to the operating characteristics of the commuter rail service involving different corridor lengths and the number of stations.

Freight Track Ownership Options

Milestone 2 included a discussion of several models for rail right-of-way ownership. Two of these options were identified as realistic and potentially viable options for ownership arrangements on the two private freight railroads in the MAG region.

Cost estimates developed as part of Milestone 4 assumed a combination of the two models with the purchase of a portion of each freight railroad line in order to operate the Phase 3 service, while access rights are leased in Phase 1 and on certain lower demand portions of corridors in Phase 3. The revised cost estimates below explore the implications of using operating windows for commuter rail trains assigned to run during peak periods to reduce capital costs during the initial start-up of commuter rail service. This arrangement would allow for earlier implementation of commuter rail service and spread out the high capital cost of full service implementation over a greater period of time.

<u>BNSF Line</u>

The largest single capital cost item on the BNSF corridor was the implementation of a second main track along the entire 26.18 mile corridor between downtown Phoenix and Surprise. This track was deemed to be required because of the operating characteristics of the BNSF freight service. The BNSF main line terminates in downtown Phoenix, allowing BNSF to use the main track in a form similar to a yard track where extensive car switching activity takes place, preventing or impeding possible through passenger rail service. The impacts caused by BNSF operations are compounded by the limited yard space BNSF possess in the Phoenix region and their inability to accommodate all freight switching facilities within the existing yard.

A possible option for reducing the initial capital cost of commuter rail service in the BNSF corridor would be to relocate the BNSF freight yard, allowing unimpeded commuter train operation within the metropolitan MAG region during specific operating windows negotiated with BNSF. BNSF has been exploring the possibility of relocating their freight yard off the main track to a location northwest of their existing automotive facility at El Mirage. The yard relocation and the elimination of switching activity on the main track could allow for commuter rail operations on the existing main track and eliminate the need for a second main track during the first phase of commuter rail service.

Revised capital and operating costs have been developed estimating the impact of the relocation of the BNSF yard and the lease of track rights upon the operation of commuter rail service. The cost of relocating the BSNF yard is not included in this cost estimate. A decision about possible public funding for part of this relocation would come after negotiations with BNSF. The revised capital costs are presented in Table 1 below. Lease costs represent an estimate of $6.00 per train mile. This figure is based upon an average of lease costs paid by commuter rail operators in the United States. The actual lease cost would be set through negotiation with BNSF and could vary dramatically from this estimate.

The alternative explored involves the lease of rights during the Phase 1 start-up service. The cost is based upon the Year 2020 ridership levels. This option assumes the construction of a second main track, implementation of Centralized Traffic Control (CTC) signals, and the purchase of the underlying right-of-way for the Phase 3 level of service where leasing does not occur. The benefit of this proposal is delaying the cost of implementing the second main track over a longer period of time, allowing for the identification of sufficient funding and growth in ridership. The capital and operating costs for implementing this option are summarized in Table 5.1-14. Operating costs are the same because the lease of rights for using the second main track was assumed in the original cost estimate. This cost estimate is dependent upon the relocation of the BNSF freight yard, but does not include an estimate for this cost.

Table 5.1-14 **BNSF Track Lease Options**

Phase	New Capital Cost ($ millions)	New Annual Operating Cost ($ millions)	Cost Effectiveness with Lease	Standard Investment Cost Effectiveness
Option 1 (Lease only in Phase 1)				
1	$174.05	$4.90	$25.81	$38.78

Note: These costs do not assume the cost for relocating the BNSF freight yard. The Standard Investment is considered to be a second main track along the entire 26.18 mile corridor and is the cost estimate contained in Table 5.1-12 above.

As shown in Table 5.1-14 above, commuter rail in the BNSF corridor becomes more cost effective if it is capable of being implemented without a second main track during Phase 1. This scenario would allow for phased implementation of additional service and a second main track, allowing for incremental service to be provided and supplying benefit to the corridor. Infrastructure implementation would be matched more closely to available funding and ridership demand. The likely deciding factor in this configuration is the outcome of future negotiations with BNSF and the cost of relocating the freight yard north of El Mirage. Any public costs involved in this relocation could make this alternative financially unfeasible. Further negotiations with BNSF will be required to determine the best course of action. According to BNSF, the operation of commuter rail in freight windows would not be possible without the yard relocation.

UP Mainline/Chandler

Negotiating operating widows and leasing track rights could be feasible on the Union Pacific Mainline/Chandler line during Phase 1 of commuter rail service. Additional discussions and negotiations with Union Pacific would be required to determine the overall likelihood of operating windows. The Union Pacific corridor experiences a larger amount of freight traffic than the BNSF, possibly impeding the lease of track rights. The capital cost of implementing Phase 1 commuter rail using Year 2020 ridership forecasts on the UP Mainline/Chandler line with leased track rights in Phase 1 is estimated in Table 5.1-15 below.

Table 5.1-15 **UP Mainline/Chandler Track Lease Options**

Phase	New Capital Cost ($ millions)	New Annual Operating Cost ($ millions)	Cost Effectiveness with Lease	Previous Cost Effectiveness
Option 1 (Lease only in Phase 1)				
1	$178.81	$1.85	$78.50	$113.92

The Standard Investment is considered to be a second main track along a 17.77 mile potion of the corridor and is the cost estimate contained in Table 5.1-12 above.

UP Southeast Line

Similar to the situation on the UP Mainline/Chandler line, negotiating operating widows and leasing track rights would likely only be feasible on the Union Pacific Southeast line during Phase 1 of commuter rail service. The capital cost of implementing Phase 1 commuter rail using Year 2020 ridership forecasts on the UP Southeast line is estimated in Table 5.1-16 below.

Table 5.1-16 **UP Southeast Track Lease Options**

Phase	New Capital Cost ($ millions)	New Annual Operating Cost ($ millions)	Cost Effectiveness with Lease	Previous Cost Effectiveness
Option 1 (Lease only in Phase 1)				
1	$178.69	$3.05	$58.70	$83.51

The Standard Investment is considered to be a second main track along a 17.77 mile potion of the corridor and is the cost estimate contained in Table 5.1-12 above.

Another alternative for implementing service in the BNSF or UP corridors is the purchase of the entire freight rail right-of-way, with the freight rail operator(s) then leasing rights to use the track owned by MAG or another public agency in the MAG region. This alternative would likely increase the initial capital cost of the service due to the cost of purchasing the rail right-of-way. Long-term operating costs would be reduced since the commuter rail agency would receive an annual lease payment from the freight operator for the use of the tracks. However, this long-term cost savings would not likely off-set the initial capital cost of purchasing the corridor. The benefit of this arrangement would be that the commuter rail operating agency would be in control of dispatching and scheduling.

There are several available examples for the possible cost of a freight corridor purchase:

- San Diego (North County Transit District - Coaster): Purchased a 39 mile portion of mainline freight corridor for $90 million ($2.3 million per mile).
- Los Angeles (Southern California Regional Rail Authority – Metrolink): Purchased 43 miles of mainline freight corridor in Orange County for $100 million ($2.33 million per mile).
- Miami (Tri-Rail): Purchased 81 miles of mainline freight corridor for $264 million ($3.26 million per mile).
- Salt Lake City (Utah Transit Authority): Purchased 120 miles of freight corridors comprised of mainline and abandoned industrial spurs as well as access rights to 30 miles of mainline freight corridor for $185 million ($950,000 per mile).

These purchases can be used as a guide for the estimated cost of purchasing freight railroad rights-of-way. However, the purchase of freight railroad rights-of-way in the MAG region may result in dramatically different costs. Freight railroad companies negotiate purchase prices on a case-by-case basis and the experiences of public agencies in other metropolitan regions cannot be directly correlated to a likely scenario in the MAG region. Given this fact, it is difficult to develop an accurate cost estimate for this scenario.

<u>UP Yuma Line</u>

The cost estimates in Milestone 4 for the UP Yuma corridor include the cost of lease track rights through all three phases of service. This corridor was determined to not need a second main track for implementing commuter rail service; therefore no alternative ownership configurations have been studied. This corridor experiences a much lower level of freight railroad traffic than the portion of the Union Pacific line east of Phoenix because of the closure of the corridor west of Palo Verde to Yuma. In effect, the UP Yuma corridor operates more like a branch line than a mainline. The reduced amount of traffic along this portion of the line allows for the implementation of commuter rail service with only the addition of a two mile siding for freight car switching activities.

Alternative Service Plans

Additional work has been done on the UP Yuma corridor to determine if lengthening the corridor to serve the Palo Verde Nuclear Generating Station (NGS) would provide an additional source of ridership and reduce congestion in the corridor. As previously proposed, the UP Yuma corridor extended from downtown Phoenix to Buckeye, a distance of 30.9 miles. The addition of service to Palo Verde NGS adds approximately 20 miles to the corridor length. Capital and operating costs in Phase 3 have been revised to study a commuter rail corridor from downtown Phoenix to Palo Verde NGS, a distance of 50.7 miles. Preliminary ridership estimates have estimated that service to Palo Verde would provide an increase in ridership of 90 round trips per day (0.7% of projected ridership). The revised costs for this service are presented in Table 5.1-17 below.

Table 5.1-17 **UP Yuma Cost Estimate to Palo Verde NGS**

New Capital Cost ($ millions)	New Annual Operating Cost ($ millions)	Cost Effectiveness to Palo Verde	Cost Effectiveness to Buckeye
$576.68	$36.75	$22.79	$16.66

Given the increase in costs required to provide service to Palo Verde and limited increase in ridership, extending commuter rail serve to this employment center is not recommended. Instead, a more efficient form of transit service could be used to connect the end of the commuter rail line in Buckeye directly with the Palo Verde facility. In this scenario, commute trips to Palo Verde NGS could be served by an express BRT service originating at the Buckeye or Goodyear commuter rail stations. Similar types of this Express BRT transit service have been implemented in several metropolitan commuter rail corridors where extensions of commuter rail service would not be cost-effective given the number of projected riders. Specifically this service is provided by GO Transit in Toronto on the Lakeshore East Line beyond the commuter rail terminal station in Oshawa to the suburb of Newcastle. The express bus route is capable of providing a much more cost-effective form of transit service given the reduced number of riders along this portion of the route. In this configuration the express buses are timed to meet each commuter rail train at the Oshawa station and allow passengers to make a quick transfer between modes with little impact upon travel time.

Diesel Multiple Unit Technology

All of the recent "New Starts" commuter rail operations which have become operational in the last 10 years share a similar vehicle technology consisting of diesel locomotive-hauled trains operated in a push-pull configuration. West Coast commuter rail providers not only share train technologies, but also manufacturers. The most common diesel locomotive in use is manufactured by General Motors. Passenger cars are bi-level vehicles manufactured by Bombardier Transportation. The one commuter rail agency to deviate from this technology was the Trinity Railway Express in Dallas, Texas. This agency operated Budd Rail Diesel Cars (RDC) for a short period during the initial implementation of commuter service between Dallas and its suburb of Irving. The RDCs have since been replaced by traditional locomotive-hauled trains.

Recently, a new type of commuter rail technology has been implemented in North America. The Diesel Multiple Unit (DMU) rail vehicle has been successfully used in Europe for many years, but had not appeared in North America due to the inability of existing designs to meet Federal Railroad Administration (FRA) safety regulations. After receiving a waiver from the Canadian government, a DMU service was implemented in Ottawa, Canada using DMU trains built by Bombardier Transportation. These vehicles are operated on a lightly used freight railroad corridors with freight train traffic restricted to operating between 1:00 a.m. and 5:00 a.m. when no passenger rail service is operated. The Ottawa DMU system operates in a style similar to a light rail transit system on a five mile route with 20 minute headways throughout the day. However, the Talent DMU design can be configured for a commuter rail type operation as well.

Several other agencies are exploring the use of DMU vehicles for commuter rail and light rail transit service. Transit operators in Sonoma and Marin Counties, California; Raleigh-Durham, North Carolina; and Tampa, Florida have all studied the potential of DMU vehicles. A new DMU light rail line is also under development in New Jersey.

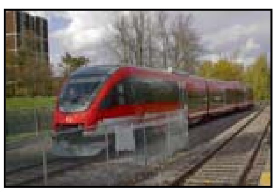
Another manufacturer, Colorado Rail Car, has announced that they have designed a DMU vehicle which meets FRA safety regulations. Given the long-term nature of this study, it is reasonable to explore a scenario where both the Talent and the Colorado Rail Car DMUs are fully certified by the FRA for use in mixed freight and passenger corridors. Research into the current Federal Transit Administration’s New Starts process has revealed that two public agencies have submitted DMU-based commuter rail projects to the Federal funding process. These DMU systems are proposed in Raleigh-Durham, North Carolina and Tampa, Florida. Both projects are in the Preliminary Engineering phase.

DMUs possess several operational advantages over conventional locomotive trains. The DMU vehicles are usually less expensive than a comparable locomotive-hauled unit on a per passenger basis, are more fuel-efficient, and are capable of quicker acceleration and deceleration rates thanks to lower overall weight. Disadvantages include the need for additional vehicles if single-level vehicles are selected, possible increases in maintenance costs due to the relative uniqueness of the technology in North America, and possible early replacement of vehicles and limited life cycle. Several European train operators have been replacing Talent vehicles after 10 to 15 years of revenue service, while standard locomotive-hauled coaches will operate for approximately 30 years.

Colorado Rail Car DMU

The Colorado Rail Car DMU is a new rail product typically referred to as a Heavy DMU. This vehicle is said to meet FRA safety standards. No examples of these DMU vehicles are available in revenue service at this time. However, several agencies around the United States have been evaluating these vehicles for implementation as part of future commuter rail systems. The only current service example for these vehicles is on sight-seeing rail corridors in Alaska.

There are three DMU vehicles produced by Colorado rail car for commuter rail revenue service. According to the manufacturer, train consists would likely be led by single-level "Aero" model which presents a more aerodynamic front, improving fuel-efficiency. Additional vehicles would consist of either bi-level or single level trailers. Each vehicle would be self-propelled and would be capable of leading a train consist of vehicles. The single level DMU vehicles are projected to carry approximately 90 seated passengers, while the bi-level DMU carries approximately 180 passengers.



Examples of the three commuter vehicle technologies. The Colorado Rail Car bi-level DMU is on top. The central photo is the Bombardier Talent in Ottawa. The bottom picture is the conventional locomotive train operated by Dallas Trinity Railway Express.

Bombardier Talent DMU

The Bombardier Talent DMU vehicle has a more extensive revenue service history than the Colorado Rail Car DMU. Various configurations of the Talent DMU have been implemented into revenue service throughout Europe, primarily in Norway and Germany. There is one North American version of the Talent DMU operating on a five mile corridor in Ottawa, Canada. The Talent is a versatile vehicle which can be implemented either as a light rail type vehicle for short-distance trips, or as a more comfortable commuter rail style vehicle. A typical configuration of Talent DMU could accommodate 85 seated passengers per vehicle. The disadvantage of this vehicle is that it is not certified for use in mixed rail traffic freight rail trains. At this time, these vehicles are limited to operations during specified operating windows where no freight rail traffic is present. The Ottawa DMU system operates with a 17 hour span of service and freight traffic limited to operating from 1:00 a.m. to 5:00 a.m. While the current operations of this vehicle limit its feasibility in the MAG region, enhancements could be made to the Talent or similar European-made DMUs over time to meet FRA safety standards, so it is appropriate to consider this technology for possible implementation in the future.

Diesel Multiple Unit Costs

Capital and operating costs have been developed for the implementation of commuter rail service using DMU trains. There are some differences in the operating characteristics of DMU trains compared to conventional push-pull locomotive in that DMUs are capable of greater acceleration/ deceleration rates. Table 5.1-18 summarizes the capital cost of implementing DMU service with each of the two vehicles described above along with a comparison to the conventional locomotive cost estimates. Table 5.1-18 provides a summary and comparison of operating costs for the three vehicle types.

For Colorado Rail Car DMUs, cost estimates have been produced assuming the use of single-level "Aero" vehicles and bi-level rail cars on the BNSF and UP Yuma corridors and single-level "Aero" and trailer vehicles on the Union Pacific Southeast and Chandler corridors. The single-level vehicles have a lower capital cost, so they were chosen for corridors with lower ridership levels and less required passenger capacity.

Table 5.1-18 **DMU Capital Cost Table**

Corridor	Colorado Rail Car DMU ($ millions)	Bombardier Talent DMU ($ millions)	Conventional Locomotive ($ millions)
BNSF Phase 1	$302.54	$299.76	$292.30
BNSF Phase 3	$426.15	$430.32	$445.63
BNSF Total	**$728.69**	**$730.08**	**$737.93**
UP Mainline/Chandler Phase 1	$253.04	$251.78	$269.93
UP Mainline/Chandler Phase 3	$229.05	$203.88	$260.29
UP Mainline/Chandler Total	**$482.10**	**$455.66**	**$530.22**
UP Southeast Phase 1	$257.58	$250.62	$270.34
UP Southeast Phase 3	$259.58	$266.54	$297.15
UP Southeast Total	**$517.16**	**$517.16**	**$567.50**
UP Yuma Phase 1	$129.72	$129.78	$143.25
UP Yuma Phase 3	$302.86	$319.56	$308.55
UP Yuma Total	**$432.58**	**$449.27**	**$451.80**

Note: Phase 1 costs reflect the Year 2020 ridership projections. Phase 3 costs are for the Ultimate level of service in the Year 2040.

<u>Capital Cost Assumptions</u>

Colorado Rail Car DMU vehicle costs are estimated by the manufacturer to be $3 million for both the single level "Aero" model and a bi-level trailer model. A $2 million single level trailer is also available. The single level vehicles have a passenger capacity of 90 people, while the bi-level can hold 180. Train consists would include an Aero vehicle in front, trailed by as many bi-level trailers as necessary to accommodate projected riders. The only changes to the capital costs for service with Colorado Rail Car vehicles is the overall vehicle cost and adjustments to the maintenance and storage facility cost based upon the change in the number of vehicles.

As is the case with the Colorado Rail Car capital cost assumptions, the only changes for Talent DMU costs are for vehicles and the maintenance facility. A cost of $2 million per vehicle has been assumed based upon the cost of vehicles for the O-train in Ottawa.

Both the BNSF and UP Yuma corridors have a high level of passenger demand which requires a large number of vehicles for both locomotive-hauled service and DMU service. The smaller size of the Talent DMU requires a substantial number of these vehicles be purchased to operate service in the BNSF corridor. This effect is somewhat mitigated in the UP Yuma corridor. The UP Southeast and UP Mainline/Chandler corridors see cost reductions because of the reduced number of vehicles required and elimination of costs to purchase locomotives.

Operating and Maintenance Cost Assumptions

Operating costs for the Colorado Rail Car DMU were estimated using the operating cost estimates developed for the Sonoma-Marin Commuter Rail Study (SMART). The SMART study involves a 68 mile corridor with initial service of 4 trains per day (3 peak and 1 off-peak) between Sonoma and Marin counties in the San Francisco Bay Area of Northern California. Consistent with the operating cost estimates produced in Milestone 4, the annual cost per revenue mile and revenue hour for bus service in Sonoma County was compared to the 2001 Valley Metro figures in order to develop a basis for comparing the estimated annual cost of commuter rail service in the SMART corridor and on the potential MAG region corridors.

Operating costs for commuter rail service with the Bombardier Talent DMU were developed using the results of an evaluation report produced in December 2002 by OC Transpo for the City of Ottawa. The annual operating cost for this service was then converted to US Dollars using a $0.65 conversion rate. Using the 2001 operating expenses for OC Transpo bus service in Ottawa approximately compared to the Year 2001 Valley Metro service, an estimated revenue mile and revenue hour cost was calculated. Table 5.1-19 summarizes the estimated annual revenue mile and revenue hour costs used for the three commuter rail vehicles to estimate annual operating costs. Operating costs are then summarized for the three technologies in Table 5.1-20. Cost effectiveness results for the three commuter rail vehicle technologies are compared in Table 5.1-21. This cost effectiveness figure is for the Phase 3 level of service.

Table 5.1-19 **DMU Annual Revenue Mile and Hour Costs**

Vehicle	Annual Cost per Revenue Service Mile	Annual Cost per Revenue Service Hour
Conventional Locomotive-Hauled	$16.81	$487.64
Colorado Rail Car DMU	$14.32	$395.11
Bombardier Talent DMU	$10.56	$209.98

Table 5.1-20 **DMU Operating and Maintenance Cost Comparison**

Corridor	Colorado Rail Car DMU ($ millions)	Bombardier Talent DMU ($ millions)	Conventional Locomotive ($ millions)
BNSF Phase 1	$3.45	$3.94	$4.90
BNSF Phase 3	$21.15	$20.60	$22.55
UP Mainline/Chandler Phase 1	$1.55	$1.49	$1.85
UP Mainline/Chandler Phase 3	$12.71	$8.46	$14.25
UP Southeast Phase 1	$2.64	$2.31	$3.05
UP Southeast Phase 3	$14.54	$14.17	$17.50
UP Yuma Phase 1	$2.42	$2.59	$3.60
UP Yuma Phase 3	$20.69	$19.78	$22.40

Table 5.1-21 **DMU Cost Effectiveness Comparison**

Corridor	Colorado Rail Car DMU Cost Effectiveness	Bombardier Talent DMU Cost Effectiveness	Conventional Locomotive Cost Effectiveness
BNSF Phase 3	$16.40	$16.31	$16.84
UP Mainline/Chandler Phase 3	$37.48	$32.82	$41.41
UP Southeast Phase 3	$30.07	$29.87	$33.83
UP Yuma Phase 3	$15.32	$15.43	$16.22

Note: The cost effectiveness figures presented in Table 5.1-21 are for the Phase 3 level of service.

As shown in the two tables above, DMU technology does offer a potentially cost-effective alternative to conventional locomotive-hauled commuter trains. The relative uniqueness of the DMU technology in North America may create some procurement and maintenance issues. However, as the technology becomes more prevalent, these additional risks and costs will be minimized. Given the long-term horizon of this study it remains prudent to retain DMU technology as a possible option for providing commuter rail service in the MAG region. The selection of a specific technology for commuter rail in a selected freight corridor in the MAG region would require a detailed Major Investment Study (MIS). An MIS is designed to perform in-depth analysis of technologies, alignments, and costs at a level of detail that is beyond the scope of the high capacity transit plan.

5.1.2 LRT/BRT Revised Cost and Ridership

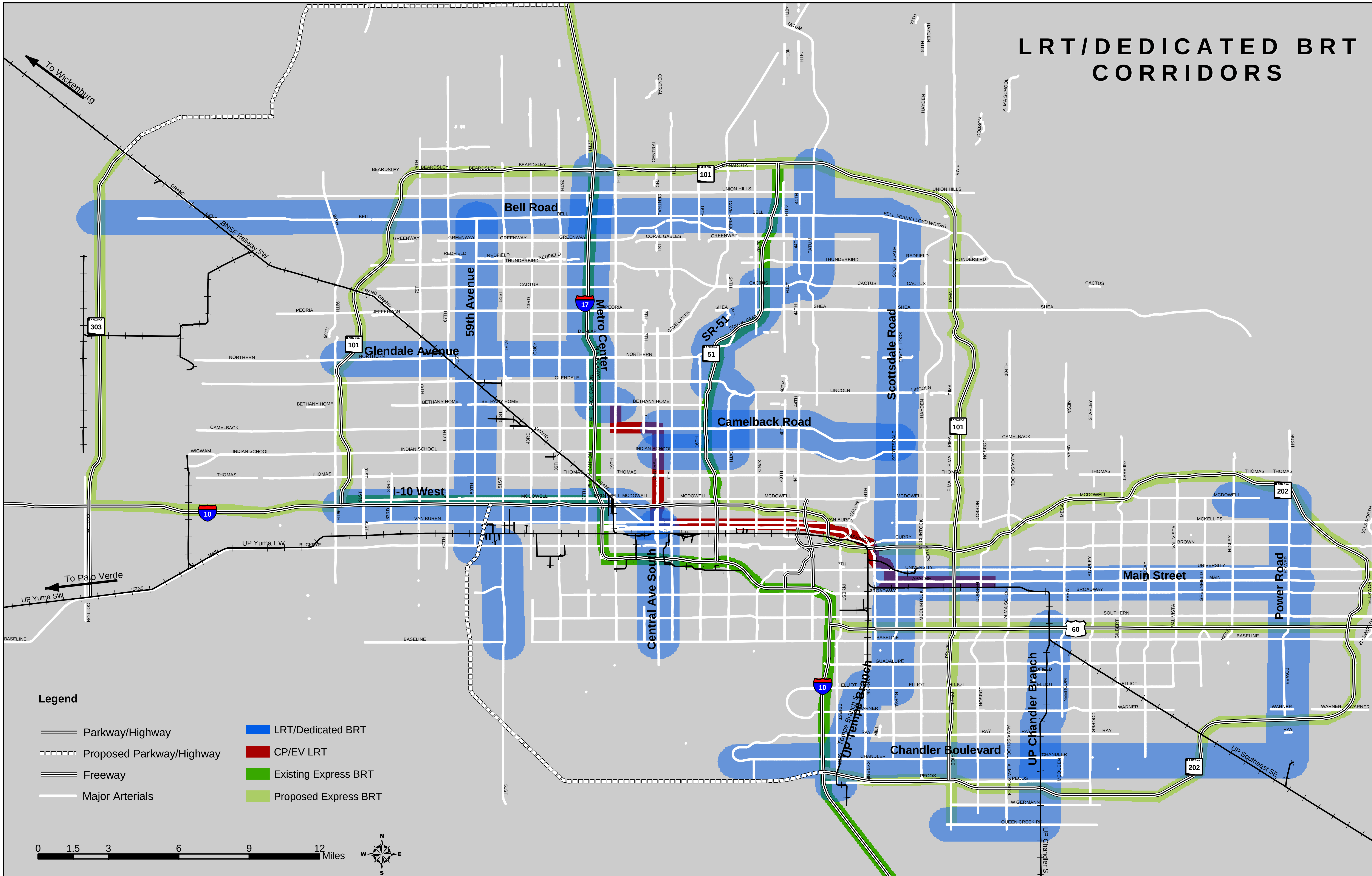
As was the case in the Milestone 4, the MAG LRT sketch planning model was utilized to estimate the potential ridership demand in each of the possible LRT/Dedicated BRT corridors. These sketch model forecasts of ridership were based upon trip rates of catchment area households. The sketch planning model combines trip production and modal split components of a standard four-stage modal in a trip rate factor. These factors are based upon on the relationship between the distances from an LRT station and LRT trip productions.

Modifications have been made to several of corridors in terms of alignment and limits as a result of comments from local agencies and consolidations of parallel or overlapping corridors. These revisions to the proposed LRT/Dedicated BRT network are explained in detail in Section 5.2.2. Table 5.1-22 provides a summary of the new corridor limits and alignments used in the ridership and cost estimates. The LRT/Dedicated BRT corridors are illustrated in Exhibit 5.1-5. Each alignment in the table represents a single centerline street or freeway selected for the development of cost and ridership estimates. The actual corridors are five miles in width and a final alignment could include other streets parallel to the alignments identified in the table.

Table 5.1-22 **LRT/Dedicated BRT Corridor Refinements**

Corridor	Previous Limits	Revised Limits	Reason for Alignment Changes
59th Avenue	51st Ave/Baseline Rd to 59th Ave/Bell Rd	Same	n/a
Bell Road	Loop 303 to Scottsdale Road	Same	n/a
Camelback Road	Loop 101 West Valley to Scottsdale Road	Central Avenue to Scottsdale Road	Western portion consolidated with Glendale Avenue
Central Avenue South	n/a	Baseline Road to CP/EV LRT alignment	New corridor
Chandler Boulevard	Ray Road to Power Road	Same	n/a

Corridor	Previous Limits	Revised Limits	Reason for Alignment Changes
Glendale Avenue (formerly Northern Avenue)	Northern/19th Avenue to Northern/Loop 101 West	Glendale/I-17 to Glendale/Loop 101 W	Consolidated with Camelback corridor, serve Glendale sports facility at Loop 101
I-10 West	Central Ave/Van Buren to I-10/Loop 101 West	Same	n/a
Main Street	CP/EV Terminus to Power Road	Same	n/a
Metrocenter	19th/Bethany Home to Metrocenter Mall (Peoria Ave/I-17)	19th/Bethany Home to Bell/I-17	Matches City of Phoenix Long Range LRT plan
Power Road	Power/Williams Field to McDowell/Higley	Same	n/a
Scottsdale Road/Rural Road	Bell Rd/Scottsdale Rd to Price Rd/Queen Creek Rd	Bell Rd/Scottsdale Rd to UP Tempe Branch southern terminus	Southern portion consolidated with UP Tempe Branch
SR-51	Central Ave/Camelback Rd to Tatum/Loop 101	Central Ave/Indian School to Tatum/Loop 101	Match alignment to City of Phoenix Long Range LRT plan
Union Pacific Chandler Branch	Price Rd/Queen Creek Rd to UP Mainline	Price Rd/Queen Creek Rd to Main St/Mesa Rd	Connect to Main Street Corridor
Union Pacific Tempe Branch	UP Mainline (Tempe Junction) to southern terminus (56th St/I-10)	None	Consolidated with Scottsdale/Rural corridor


LRT/DEDICATED BRT CORRIDORS
Bell Road
Glendale Avenue
59th Avenue
Metro Center
SR-51
Camelback Road
Scottsdale Road
I-10 West
Central Ave South
Main Street
Power Road
Chandler Boulevard
UP Chandler Branch
UP Tempe Branch
To Wickenburg
To Palo Verde
BNSF Railway SW
UP Yuma EW
UP Yuma SW
UP Southeast SE
Legend
Parkway/Highway
Proposed Parkway/Highway
Freeway
Major Arterials
LRT/Dedicated BRT
CP/EV LRT
Existing Express BRT
Proposed Express BRT
0 1.5 3 6 9 12 Miles
January 3, 2003
LRT-BRT Map

Ridership estimates produced for the LRT/Dedicated BRT corridors in Milestone 4 were based upon the previous population projections and assumed a standardized station spacing of ½ mile along the entire route. These estimates have been revised for this report by applying the sketch planning model to the new population projections. Station locations were also revised to more accurately match the proposed number of stations in the capital cost estimates. Stations are now assumed to be located on average about one mile apart. This station spacing is more consistent with other West Coast LRT systems and the majority of Central Phoenix/East Valley (CP/EV) LRT system which only has ½ mile station spacing on Central Avenue in downtown Phoenix. Station spacing is also consistent with projected population densities and the existing street grid present in the MAG region. Midblock stations would be more difficult to access for pedestrians and would negatively impact operational speed and time. The station spacing does impact ridership figures and results in lower ridership projections since a reduced portion of the population in each corridor resides within ½ mile of a station.

Cost estimates for implementing LRT in the proposed corridors were updated with new unit values derived from other West Coast LRT projects, including the CP/EV project. These revisions to the unit values have had a minimal effect upon the overall estimates in each corridor, usually less than $1-2 million per mile. BRT costs were revised to account for the paving of the BRT guideway with concrete instead of asphalt pavement. It is assumed that concrete would be a more durable material for the guideway and the initial capital costs would be offset by the reductions in long-term replacement and repair costs in the corridor.

Revised LRT/Dedicated BRT Ridership

LRT forecasts were also developed using a direct demand style model, which relates average daily ridership to catchment area households and the proximity of corridor employment to the stations. The methodology is described in Milestone 4 and no major changes have been made for the revised forecasts. However, updates have been developed due to some changes in the corridor definitions, and a change in the assumption on station spacing. Corridor alignment changes are described in more detail in Table 5.1-22 above and in Section 5.2.2. The average distance between stations is now assumed to be a mile, rather than the half-mile spacing assumed in Milestone 4. A third and highly significant impact on ridership is the major changes in population and employment forecasts explained earlier in this report.

Ridership forecasts were developed for each corridor in isolation, with population and employment totals developed for distance bands around LRT stations. Forecasts were determined by application of these figures to the trip rate factors in Table 5.1-23 below.

Table 5.1-23 **Average Trip Rate Factors**

	Station to Destination Travel Distance			
Home to Station Travel Distance	**0-1/4 MILES**	**1/4-1/2 MILES**	**0-2 MILES**	**Sum**
0-1/4 mile	3.32	0.88	0.36	4.56
1/4-1/2 mile	0.74	0.21	0.03	0.98
0- 2 miles	0.40	0.09	0.04	0.53
2-5 miles	0.23	0.03	0.02	0.28
Sum	4.69	1.21	0.45	6.35

Average daily boardings were determined as the product of the number of households, the proportion of employment for each cell in the table above, and the respective trip factor, i.e.

$$Trips = Households_O * JobFraction_D * TripRateFactor_{OD}$$

Where Households_O is number of households within distance O of a station (origins), and JobFraction_D is proportion of regional [corridor] jobs within distance D of a station (destinations)[2]

Changes in population (and hence household) projections are the most significant impact on the ridership forecasts, and are described in the section above on commuter rail forecasts. The main impact is an increase in growth in the West Valley, and reduction in the central areas and East Valley. Since most of the LRT routes are in more central areas, this may be expected to reduce ridership. However the local distribution of population is more important in the LRT forecasts and so even where the general corridor population has fallen, ridership may still increase if population immediately adjacent to the line has increased.

Regional changes in employment forecasts have less of an effect, as the sketch planning model only uses the local distribution of employment within the corridor (i.e. proximity to the stations) and not the strategic distribution in the entire MAG region. If anything, the increase in outer area employment at the expense of the central area may be expected to slightly reduce ridership.

Updated forecasts are shown below in Table 5.1-24. Note that five corridors have also been evaluated as extensions of the proposed Central Phoenix and East Valley (CP/EV) LRT line to give some indication of the benefit of through-running service. These extension figures were not used in any of the evaluation processed contained later in the report. They are presented solely for reference. Where possible, the change from Milestone

[2] Phoenix Model Development Project, Sketch Planning Analysis Report, Parsons Brinckerhoff Quade & Douglas Inc, November 1999

4 is shown, but for a number of corridors the changes to the network are too large for comparison.

An additional corridor included in the ridership table is a hybrid Express/ Dedicated BRT service on Grand Avenue. This service was analyzed at the request of cities in the corridor as an alternative technology if commuter rail was deemed infeasible. The service proposed involves buses operating in mixed-flow traffic for a majority of the route. Exclusive queue jumping lanes are proposed at signalized intersections, along with signal priority systems. This type of operation is not as efficient as a full Dedicated BRT service, but is a substantial upgrade above standard bus service.

Table 5.1-24

Updated LRT/BRT Ridership Projections

Corridor	Length	Estimated Average Daily Boardings	Boardings per Mile	Percent Change from Milestone 4
59th Avenue	19	12,829	675	-36%
Bell Road	29	19,750	691	-33%
Camelback	9	8,126	945	-21%
Central Avenue South	5	5,749	1,150	n/a
Chandler Boulevard	17	12,226	741	1%
Glendale	10	7,226	737	n/a
I-10 West	11	13,765	1,251	32%
Main Street	10	9,697	1,010	-6%
Metrocenter/I-17	9	8,848	1,005	n/a
Power Road	13	8,653	666	-30%
Scottsdale Road/Tempe Branch	26	20,672	811	-15%
SR-51	17	12,334	713	23%
UP Chandler Branch	13	12,534	995	-29%
Grand Avenue	26	11,770	456	n/a
As extensions				
Metrocenter/I-17	9	14,178	1,611	-4%
Central Avenue South	5	6,316	1,263	n/a
Glendale Avenue	10	8,753	893	n/a
SR-51	17	18,046	1,043	n/a
Main Street	10	16,246	1,692	n/a

Notes: Metrocenter was only forecasted as an extension in Milestone 4. For more detail on alignment changes see Table 5.1-22.

As suggested by the changes in population and station-spacing, most of the LRT projections have declined from those originally developed for Milestone 4. The doubling of station intervals reduces ridership forecast by up to 20 percent, with the remainder of the ridership difference due to corridor definition changes and population and employment projection changes. 59th Avenue, Bell Road, Power Road and the UP Chandler Branch are reduced the most, mainly due to changes in the distribution of population. I-10 West and SR-51 increased compared to Milestone 4 reflecting the general increase in development in the west and in the far north.

When corridors are assumed to act as extensions of the Phoenix/East Valley LRT ridership is increased significantly due to the larger overall corridor catchment size. However, this effect is very weak for the Glendale corridor, and it is believed this may indicate more self-containment within the Glendale corridor due to the employment in downtown Glendale.

Similar to Milestone 4, the strongest corridors in terms of ridership are I-10 West, Main Street and the Metrocenter/I-17 corridor. SR-51 also performs well if it is extended into the downtown area rather than terminating at Indian School and Central Avenue. However, as noted in Milestone 4 these forecasts are made for each corridor in isolation and so do not include interactions between corridors. The next task will attempt to develop forecasts using the MAG Model and thus include the ability to interchange between lines.

The photos above illustrate ballasted track (top), embedded track (center), and a transition from embedded to ballasted (bottom).

Revised LRT Cost Estimates

The capital and operating and maintenance costs have been revised for each of the 12 potential LRT corridors to reflect updates to the unit costs and changes to several of the alignments in each corridor.

<u>Capital Cost Estimates</u>

The revised costs are provided using ballasted track along the majority of the proposed alignment, with the LRT system operating at-grade except when crossing freeways or waterways. This type of track guideway is less costly than the alternative configuration of embedded track. However, embedded track has been assumed in every intersection along the corridors to allow for automobiles to cross the tracks. As was the case in Milestone 4 these costs are planning level estimates made without the benefit of detailed plans. More precise costs would be produced in the latter stages of project design and development.

Table 5.1-25 provides a comparison between the capital costs in Milestone 4 and the revised capital costs presented in this report. Table 5.1-26 summarizes the capital cost estimates for each of the potential LRT corridors.

Table 5.1-25 **LRT Cost Comparison Table**

LRT Corridor	Previous (Milestone 4) Capital Costs ($ millions)	Revised Capital Costs ($ millions)	Change in Capital Costs (MS 4 to MS 5)
59th Avenue	$767.58	$727.81	-$39.77
Bell Road	$1,137.65	$1,102.24	-$35.41
Camelback Road	$881.03	$349.36	-$531.67
Central Avenue South	n/a	$228.03	n/a
Chandler Boulevard	$651.89	$683.75	$31.86
Glendale Avenue	$248.87	$429.22	$180.35
I-10 West	$388.58	$399.34	$10.76
Main Street	$360.49	$373.63	$13.14
Metrocenter/I-17	$220.04	$337.65	$117.61
Power Road	$498.20	$465.10	-$33.1
Scottsdale Road	$1,244.02	$1,010.84	-$233.18
SR-51	$837.67	$823.28	-$14.39
Union Pacific Chandler Branch	$495.97	$460.86	-$35.11

Notes: The Glendale Avenue MS 4 cost is for Northern Avenue east of Grand Ave. The UP Tempe Corridor was combined with the Scottsdale Corridor, so the capital costs for UP Tempe are not presented here.

Table 5.1-26	Light Rail Capital Cost Summary

Item	59th Avenue	Bell Road	Camelback Road	Central Avenue South	Chandler Boulevard	Glendale Avenue	I-10 West	Main Street	Metrocenter	Power Road	Scottsdale Road	SR-51	Union Pacific Chandler Branch
Corridor Length (miles)	18.99	28.55	8.63	4.93	16.45	9.75	11.05	9.64	8.57	13.04	25.55	17.34	12.60
Subtotal-Civil Site Mods	$30,623,475	$46,068,200	$14,460,650	$8,240,360	$24,023,900	$14,968,000	$16,671,100	$16,611,225	$12,400,000	$21,521,600	$35,044,000	$19,239,625	$6,649,000
Subtotal-Guideway	$59,824,711	$57,522,832	$18,699,834	$25,921,714	$76,783,124	$40,108,440	$15,656,856	$9,438,841	$17,705,140	$22,498,116	$80,841,180	$132,328,105	$16,287,072
Subtotal-Utilities	$42,622,825	$64,076,400	$19,365,550	$11,062,920	$36,922,300	$21,879,000	$24,796,200	$21,632,075	$19,635,000	$29,267,200	$57,222,000	$38,910,875	$28,274,400
Subtotal-Track	$37,720,905	$54,663,360	$16,733,070	$10,466,088	$33,289,020	$19,629,000	$20,913,980	$18,205,155	$16,426,800	$24,815,880	$50,311,200	$36,543,675	$25,688,160
Subtotal-Stations	$41,525,000	$61,775,000	$20,575,000	$9,375,000	$42,375,000	$24,950,000	$21,225,000	$19,350,000	$18,100,000	$25,975,000	$48,675,000	$44,275,000	$25,575,000
Subtotal-Systems & Electrical	$91,047,948	$138,079,226	$42,032,162	$23,736,523	$79,375,582	$47,058,010	$53,290,308	$46,918,268	$40,874,450	$62,750,448	$121,622,380	$81,609,960	$61,397,896
Subtotal - Facilities	$7,500,000	$12,500,000	$5,500,000	$4,500,000	$7,500,000	$6,250,000	$5,500,000	$7,000,000	$3,500,000	$5,500,000	$12,000,000	$9,000,000	$7,250,000
A. Construction Subtotal	**$310,864,864**	**$434,685,018**	**$137,366,266**	**$93,302,604**	**$300,268,926**	**$174,842,450**	**$158,053,444**	**$139,155,564**	**$128,641,390**	**$192,328,244**	**$405,715,760**	**$361,907,240**	**$171,121,528**
Environmental Mitigation	$6,217,297	$8,693,700	$2,747,325	$1,866,052	$6,005,379	$3,496,849	$3,161,069	$2,783,111	$2,572,828	$3,846,565	$8,114,315	$7,238,145	$3,422,431
B. Construction Cost Subtotal	**$317,082,161**	**$443,378,718**	**$140,113,591**	**$95,168,656**	**$306,274,305**	**$178,339,299**	**$161,214,513**	**$141,938,675**	**$131,214,218**	**$196,174,809**	**$413,830,075**	**$369,145,385**	**$174,543,959**
C. Right of Way Subtotal	**$62,051,975**	**$101,652,400**	**$30,108,250**	**$13,527,480**	**$51,746,100**	**$30,999,000**	**$25,237,200**	**$35,506,425**	**$32,274,100**	**$46,816,900**	**$84,524,000**	**$47,870,025**	**$49,176,700**
D. Vehicles Subtotal	**$66,975,000**	**$141,712,500**	**$48,141,750**	**$34,109,250**	**$59,801,250**	**$58,293,750**	**$65,175,000**	**$58,044,000**	**$48,225,000**	**$42,525,000**	**$131,137,500**	**$89,701,500**	**$65,535,000**
Cost Contingencies (Uncertainties, Changes)													
Design&Construction	$79,270,540	$110,844,680	$35,028,398	$23,792,164	$76,568,576	$44,584,825	$40,303,628	$35,484,669	$32,803,554	$49,043,702	$103,457,519	$92,286,346	$43,635,990
Right of Way	$18,615,593	$30,495,720	$9,032,475	$4,058,244	$15,523,830	$9,299,700	$7,571,160	$10,651,928	$9,682,230	$14,045,070	$25,357,200	$14,361,008	$14,753,010
Vehicle Cost	$6,697,500	$14,171,250	$4,814,175	$3,410,925	$5,980,125	$5,829,375	$6,517,500	$5,804,400	$4,822,500	$4,252,500	$13,113,750	$8,970,150	$6,553,500
Program Implementation (Agency Costs and Fees)													
Design&Construction	$98,295,470	$137,447,403	$43,435,213	$29,502,284	$94,945,034	$55,285,183	$49,976,499	$44,000,989	$40,676,408	$60,814,191	$128,287,323	$114,435,069	$54,108,627
Right of Way Purchase	$9,307,796	$15,247,860	$4,516,238	$2,029,122	$7,761,915	$4,649,850	$3,785,580	$5,325,964	$4,841,115	$7,022,535	$12,678,600	$7,180,504	$7,376,505
Vehicle Procurement	$3,348,750	$7,085,625	$2,407,088	$1,705,463	$2,990,063	$2,914,688	$3,258,750	$2,902,200	$2,411,250	$2,126,250	$6,556,875	$4,485,075	$3,276,750
E. Capital Cost Subtotal	**$661,644,785**	**$1,002,036,156**	**$317,597,177**	**$207,303,588**	**$621,591,198**	**$390,195,669**	**$363,039,830**	**$339,659,250**	**$306,950,375**	**$422,820,957**	**$918,942,842**	**$748,435,062**	**$418,960,040**
Project Reserve	$66,164,479	$100,203,616	$31,759,718	$20,730,359	$62,159,120	$39,019,567	$36,303,983	$33,965,925	$30,695,037	$42,282,096	$91,894,284	$74,843,506	$41,896,004
F. Total Capital Cost	**$727,809,264**	**$1,102,239,771**	**$349,356,895**	**$228,033,946**	**$683,750,317**	**$429,215,236**	**$399,343,813**	**$373,625,175**	**$337,645,412**	**$465,103,053**	**$1,010,837,127**	**$823,278,568**	**$460,856,044**

Note: All costs are in 2001 Dollars. Detailed cost information can be found in Appendix B.

The changes made to unit costs and quantity assumptions within each cost category are summarized below:

- **Civil Site Modifications** – This category includes widening streets and intersections to accommodate the rail guideway, and modifications to traffic signals to match the new traffic lane alignment. No changes were made to the costs included in this category.
- **Guideway** – The cost of the guideway structure or base is estimated in this category. Unit costs for surface track guideway were revised upward for both ballasted and embedded track.
- **Utilities** – This cost accounts for the relocation of utilities within the corridor. This unit cost has been revised down from previous estimates.
- **Track** – This category presents the costs for installing new trackwork in the corridor. The unit costs for direct fixation track (aerial) and ballast track have been revised upward. Embedded track unit costs are revised downward.
- **Stations** – The cost of implementing light rail stations, including associated parking is included here. For the purposes of this cost estimate parking was assumed to be distributed evenly between surface lots and parking structures. An average of 150 parking spaces is estimated at each station. Station costs have been revised upward.
- **Systems & Electrical** – The cost of installing the electric power distribution systems, ticket vending machines, and corridor lighting are included here. Modifications were made to each unit cost is this category, resulting in a slightly high cost for each corridor.
- **Facilities** – The cost of an operations control and dispatching center is estimated here along with the cost of a maintenance and storage facility. The maintenance and storage facility cost has been scaled to accommodate the number of vehicles estimated to provide service in the corridor.
- **Environmental Mitigation** – This is a cost allowance added to the construction costs identified above which would be used to provide spot mitigation measures such as landscaping that could be identified later in the implementation process. The percentage has been revised to 2% of the construction cost.
- **Construction Add-ons** – These percentages remain the same.
- **Right-of-Way** – This category includes the land required to accommodate the system. Right-of-way costs assume the costs of purchasing 23 feet of right-of-way in each arterial street corridor where the system is assumed to run at-grade. Aerial portions of the alignment are assumed to not require additional right-of-way since the guideway

support structures would be located entirely in the existing median. The cost estimate also includes the cost of right-of-way for stations and parking lots. No changes were made to this category.

- **Right-of-Way Add-ons** – These percentages remain the same.
- **Vehicles/Maintenance of Way** – This category includes the light rail vehicles, spare parts, and maintenance of way equipment. No changes were made to these estimates.
- **Vehicle Add-ons** – These include contingencies for the price of the light rail vehicles, and the cost of the procurement, testing, and commissioning of the vehicles. These percentages remain the same.

Detailed LRT capital cost estimate information is provided in Appendix B.

Operating and Maintenance Cost Estimates

No changes were made the assumptions for calculating the annual operating and maintenance costs for the LRT corridors. The changes to these cost estimates result from the proposed changes to the recommended alignments for selected corridors and revisions to the number of stations on each alignment. Table 5.1-27 identifies the proposed peak headways for LRT service in each corridor. Off-peak headways are assumed to be twice the peak headway. Modifications to the assumed headways were made to two corridors, Power Road and I-10 West. Both corridors are now assumed to provide more frequent service to accommodate projected ridership demand.

Table 5.1-27 **Proposed LRT Headways**

LRT Corridor	Assumed Peak Period Headway (minutes)
59th Avenue	15
Bell Road	10
Camelback Road	10
Chandler Boulevard	15
Glendale Avenue	10
I-10 West	10
Main Street	10
Metrocenter/I-17	10
Power Road	15
Scottsdale Road	10
SR-51	10
Union Pacific Chandler Branch	10

Table 5.1-28 summarizes the annual operating and maintenance costs for the 12 potential LRT corridors. Costs are in Year 2001 dollars. Estimated operating and maintenance costs for these corridors in Milestone 4 are presented here for reference. Detailed operating and maintenance cost estimates can be found in Appendix B.

Table 5.1-28
Light Rail Operating and Maintenance Costs

LRT Corridor	Previous (Milestone 4) Annual O&M Cost ($ millions)	Revised Annual O&M Cost ($ millions)	Change in O&M Cost (MS 4 to MS 5)
59th Avenue	$11.35	$11.29	-$0.06
Bell Road	$22.58	$22.55	-$0.03
Camelback Road	$17.12	$7.63	-$9.49
Chandler Boulevard	$9.79	$9.74	-$0.05
Glendale Avenue	$6.13	$8.96	$2.83
I-10 West	$6.79	$10.29	$3.50
Main Street	$8.96	$8.96	$0.00
Metrocenter/I-17	$4.93	$7.61	$2.68
Power Road	$7.22	$8.26	$1.04
Scottsdale Road	$22.58	$20.95	-$1.63
SR-51	$14.16	$14.34	$0.18
Union Pacific Chandler Branch	$10.44	$10.44	$0.00

Note: The Glendale Avenue costs have been compared to the Northern Avenue east of Grand Ave. costs from Milestone 4.

Revised Dedicated BRT Cost Estimates

Revisions have been made to the potential Dedicated BRT corridors to reflect the consolation of selected corridors, revised alignments, and modifications to unit cost values used the capital cost estimates. Capital and operating and maintenance cost estimates have been produced for nine potential Dedicated BRT corridors. The three corridors which are not presented here, Metrocenter/I-17, Glendale Avenue, and I-10 West are committed to being implemented as LRT corridors in the MAG region as a result of either ballot measures or local agency implementation plans.

<u>Dedicated BRT Corridor Capital Cost Estimates</u>

A major revision to the capital cost estimates for the Dedicated BRT corridors involves the assumption that the BRT guideway will be paved with concrete rather than asphalt as assumed in Milestone 4. This modification was made based upon the results of BRT implementation in other cities in North America. Concrete is capable of supporting BRT operations for over a longer span of time than is asphalt. Several North American transit agencies are experiencing major rehabilitation costs for asphalt BRT corridors only two or three years after implementation. Concrete pavement is expected to be capable of being used for 10 to 15 year prior to the need for rehabilitation. The cost of concrete substantially increases the initial capital cost of the Dedicated BRT corridors, but would likely reduce long-term costs and be more cost-effective over the life of the system.

As noted in Milestone 4 the Express BRT corridors evaluated in Milestone 4 are no longer being studied as part of the High Capacity Transit Plan. Instead these corridors are being taken forward as part of the Valley Metro/RPTA Regional Bus Study. Consultations with Valley Metro and MAG resulted in an agreement that these corridors could be evaluated more properly in the Regional Bus study; therefore it was decided to eliminate further study of these seven corridors as part of Milestone 5. Additionally, these Express BRT corridors have been assumed to be included as part of the underlying baseline network of high capacity transit services planned for the MAG region.

Table 5.1-29 provides a comparison between the capital costs in Milestone 4 and the revised capital costs presented in this report. Table 5.1-30 summarizes the revised capital costs for the nine potential Dedicated BRT corridors. All costs are presented in Year 2001 dollars.

The cost estimates below include a scenario for a hybrid Express/Dedicated BRT service along Grand Avenue. This service was analyzed at the request of several cities in the Grand Avenue corridor as an alternative technology in the event that commuter rail was not feasible. As noted above, the buses in this corridor will not operate in a fully exclusive lane. Instead, travel times and operations will be enhanced by the presence of queue jumping lanes at signalized intersections.

Table 5.1-29 **BRT Cost Comparison Table**

LRT Corridor	Previous (Milestone 4) Capital Costs ($ millions)	Revised Capital Costs ($ millions)	Change on Capital Cost (MS 4 to MS 5)
59th Avenue	$288.67	$359.08	$70.41
Bell Road	$408.93	$539.11	$130.18
Camelback Road	$311.29	$165.65	-$145.64
Chandler Boulevard	$242.75	$306.02	$63.27
Main Street	$142.64	$184.71	$42.07
Power Road	$189.78	$236.83	$47.05
Scottsdale Road	$449.24	$465.96	$16.72

LRT Corridor	Previous (Milestone 4) Capital Costs ($ millions)	Revised Capital Costs ($ millions)	Change on Capital Cost (MS 4 to MS 5)
SR-51	$183.45	$254.67	$71.22
Union Pacific Chandler Branch	$204.82	$225.92	$21.10
Grand Avenue	n/a	$232.48	n/a

Notes: The Milestone 4 costs presented for SR-51 are the Glendale Ave/Cactus Ave costs produced in Milestone 4. No Dedicated BRT costs were produced in Milestone 4 for the SR-51 corridor.

Table 5.1-30 Bus Rapid Transit Capital Cost Summary

Item	59th Avenue	Bell Road	Camelback Road	Chandler Boulevard	Main	Power Road	Scottsdale Road	SR-51	Union Pacific Chandler Branch	Grand Avenue
Corridor Length (miles)	18.99	28.55	20.88	16.45	9.64	13.04	28.10	17.34	11.13	25.80
Subtotal-Civil/Roadway	$42,424,191	$60,883,898	$19,011,231	$35,588,540	$21,004,746	$27,775,902	$49,293,376	$24,536,921	$18,338,604	$18,696,143
Subtotal-Utilities	$35,101,150	$52,769,150	$15,948,100	$30,406,600	$17,814,650	$24,102,400	$47,124,000	$21,418,250	$23,284,800	$19,950,000
Subtotal-Stations	$30,827,500	$47,052,500	$14,602,500	$27,582,500	$16,225,000	$21,092,500	$40,562,500	$27,582,500	$21,092,500	$21,092,500
Subtotal-Systems & Electrical	$17,625,798	$26,477,026	$8,213,222	$15,258,170	$9,080,986	$11,742,909	$23,428,500	$13,293,236	$11,756,000	$18,031,500
Subtotal Facilities	$6,600,000	$7,950,000	$3,150,000	$3,900,000	$3,450,000	$2,700,000	$7,200,000	$5,250,000	$4,050,000	$9,650,000
A. Construction Subtotal	**$132,578,639**	**$195,132,573**	**$60,925,053**	**$112,735,811**	**$67,575,382**	**$87,413,711**	**$167,608,376**	**$92,080,907**	**$78,521,904**	**$87,420,143**
Environmental Mitigation	$2,651,573	$3,902,651	$1,218,501	$2,254,716	$1,351,508	$1,748,274	$3,352,168	$1,841,618	$1,570,438	$1,748,403
B. Construction Cost Subtotal	**$135,230,212**	**$199,035,225**	**$62,143,554**	**$114,990,527**	**$68,926,890**	**$89,161,985**	**$170,960,544**	**$93,922,525**	**$80,092,342**	**$89,168,545**
C. Right of Way Subtotal	**$68,123,975**	**$106,206,975**	**$31,626,250**	**$60,854,100**	**$35,506,425**	**$48,334,900**	**$92,470,500**	**$47,870,025**	**$47,796,700**	**$33,175,600**
D. Vehicles Subtotal	**$14,520,000**	**$22,264,000**	**$6,776,000**	**$9,196,000**	**$7,744,000**	**$5,324,000**	**$19,844,000**	**$13,552,000**	**$9,680,000**	**$20,988,000**
Cost Contingencies (Uncertainties, Changes)										
Design&Construction	$33,807,553	$49,758,806	$15,535,889	$28,747,632	$17,231,722	$22,290,496	$42,740,136	$23,480,631	$20,023,086	$22,292,136
Right of Way	$20,437,193	$31,862,093	$9,487,875	$18,256,230	$10,651,928	$14,500,470	$27,741,150	$14,361,008	$14,339,010	$9,952,680
Vehicle Cost	$1,452,000	$2,226,400	$677,600	$919,600	$774,400	$532,400	$1,984,400	$1,355,200	$968,000	$2,098,800
Program Implementation (Agency Costs and Fees)										
Design&Construction	$41,921,366	$61,700,920	$19,264,502	$35,647,063	$21,367,336	$27,640,215	$52,997,769	$29,115,983	$24,828,626	$27,642,249
Right of Way Purchase	$10,218,596	$15,931,046	$4,743,938	$9,128,115	$5,325,964	$7,250,235	$13,870,575	$7,180,504	$7,169,505	$4,976,340
Vehicle Procurement	$726,000	$1,113,200	$338,800	$459,800	$387,200	$266,200	$992,200	$677,600	$484,000	$1,049,400
E. Capital Cost Subtotal	**$326,436,894**	**$490,098,664**	**$150,594,407**	**$278,199,067**	**$167,915,864**	**$215,300,901**	**$423,601,274**	**$231,515,475**	**$205,381,269**	**$211,343,751**
Project Reserve	$32,643,689	$49,009,866	$15,059,441	$27,819,907	$16,791,586	$21,530,090	$42,360,127	$23,151,547	$20,538,127	$21,134,375
F. Total Capital Cost	**$359,080,584**	**$539,108,531**	**$165,653,848**	**$306,018,974**	**$184,707,451**	**$236,830,991**	**$465,961,401**	**$254,667,022**	**$225,919,396**	**$232,478,126**

Note: All costs are in 2001 Dollars. Detailed cost information can be found in Appendix C.

The changes made to unit costs and quantity assumptions within each cost category are summarized below:

- **Civil Site Modifications** – This category includes widening streets and intersections to accommodate the Dedicated BRT lanes and modifications to traffic signals to match the new traffic lane alignment. Costs have been adjusted to more accurately reflect the possible cost for removing and rebuilding the street corridor.
- **Utilities** – This cost accounts for the relocation of utilities within the corridor. This unit cost has been revised down from previous estimates.
- **Stations** – The cost of implementing BRT stations, including associated parking is included here. The number of parking spaces at the BRT stations has been revised upward to 150 spaces per station. For the purposes of this cost estimate parking was assumed to be distributed evenly between surface lots and parking structures.
- **Systems & Electrical** – The cost of installing signal priority systems at major intersections and on-board the BRT vehicles are assumed here. This category also includes the cost of ticket vending machines, corridor lighting, and automated vehicle location (AVL) systems on the buses.
- **Facilities** – The cost of an operations control and dispatching center is estimated here. Maintenance and storage facility costs have been scaled to the number of vehicles required to provide service along the route. The cost of AVL hardware at the operations and control center and at stations is also included here.
- **Environmental Mitigation** – This is a cost allowance added to the construction costs identified above which would be used to provide spot mitigation measures such as landscaping that could be identified later in the implementation process. This number has been revised to 2 percent of the construction cost.
- **Construction Add-ons** – These percentages remain the same.
- **Right-of-Way** – This category includes the land required to accommodate the system. Right-of-way costs assume the costs of purchasing 23 feet of right-of-way in each arterial street corridor where the system is assumed to run at-grade. Freeway portions of the alignment are assumed to not require additional right-of-way since the vehicles will operate in existing or planned HOV lanes. The cost estimate also includes the cost of right-of-way for stations and parking lots.
- **Right-of-Way Add-ons** – These percentages remain the same.

- **Vehicles/Maintenance of Way** – This category includes the buses and spare parts. Dedicated BRT service is provided by 60-foot articulated buses.

- **Vehicle Add-ons** – These include contingencies for the price of the buses, and the cost of the procurement, testing, and commissioning of the vehicles. These percentages remain the same.

Detailed capital costs are available in Appendix C.

Dedicated BRT Operating and Maintenance Costs

No changes were made the assumptions for calculating the annual operating and maintenance costs for the Dedicated BRT corridors. As was the case in Milestone 4, the Year 2001 operating cost per revenue hour and revenue mile for Valley Metro bus service in the MAG region was used as the base for estimating the annual operating and maintenance cost for each of these nine corridors. Changes to these cost estimates result from the proposed changes to the recommended alignments for selected corridors and revisions to the number of stations on each alignment. No changes were made to the assumed headways. Table 5.1-31 identifies the proposed peak headways for LRT service in each corridor. Off-peak headways are assumed to be twice the peak headway.

Table 5.1-31 **Proposed Dedicated BRT Headways**

Dedicated BRT Corridor	Assumed Peak Period Headway (minutes)
59th Avenue	5
Bell Road	5
Camelback Road	5
Chandler Boulevard	7
Main Street	5
Power Road	10
Scottsdale Road	5
SR-51	5
Union Pacific Chandler Branch	5
Grand Avenue	5

Table 5.1-32 summarizes the annual operating and maintenance costs for the nine potential BRT corridors. Costs are in Year 2001 dollars. Estimated operating and maintenance costs for these corridors in Milestone 4 are presented here for reference. Detailed operating and maintenance cost estimates can be found in Appendix B.

Table 5.1-32 Operating and Maintenance Costs

Dedicated BRT Corridor	Previous (Milestone 4) Annual O&M Cost ($ millions)	Revised Annual O&M Cost ($ millions)	Change in O&M Cost (MS 4 to MS 5)
59th Avenue	$10.29	$10.29	$0.00
Bell Road	$15.64	$15.64	$0.00
Camelback Road	$11.53	$4.91	-$6.62
Chandler Boulevard	$6.59	$6.59	$0.00
Main Street	$5.35	$5.35	$0.00
Power Road	$3.71	$3.71	$0.00
Scottsdale Road	$15.23	$14.00	-$1.23
SR-51	$10.71	$9.47	-$1.24
Union Pacific Chandler Branch	$7.41	$7.00	-$0.41
Grand Avenue	n/a	$15.91	n/a

Notes: The Milestone 4 costs presented for SR-51 are the Glendale Ave/Cactus Ave costs produced in Milestone 4. No Dedicated BRT costs were produced in Milestone 4 for the SR-51 corridor.

5.1.3 Cost Effectiveness and Cost Benefit Analysis

The cost effectiveness of the high capacity transit corridors was selected as the major evaluation criteria to determine the recommended network. This method of evaluation was chosen because of its fit with the Federal transit project funding process and its ability to determine the benefits provided by a proposed transit corridor by comparing the ridership to the cost of constructing and operating the system. This section summarizes the results of a refinement of the cost effectiveness evaluation using the new ridership and cost estimates presented above.

Following the refined cost effectiveness results are the results of a benefit cost analysis of the corridors contained within the recommended high capacity transit network. This evaluation goes above and beyond the level of detail of simple cost effectiveness to incorporate the full benefits of the proposed transit corridors in relation to reductions in automobile traffic, miles traveled, and time lost to traffic congestion delays.

Refined Cost Effectiveness

The calculation of cost effectiveness remains the same from the previous Milestone report. As noted previously, this calculation does not match the Federal "New Starts" cost effectiveness calculation exactly. This difference is a result of the reliance of the New Starts' cost effectiveness figure being based upon "new" riders attracted to use the transit service. The use a sketch planning model does not allow for determining the number of new transit riders attracted to each corridor.

The objective of the cost effectiveness calculation in this study is for a comparison between the proposed transit corridors. The calculation used to compare the benefits of each corridor is:

(Project Annualized Capital Cost + Project Annual Operating Cost)/Project Annual Boardings = Cost Effectiveness

The annualized figure for capital cost is obtained by multiplying the total project capital cost by 0.08 to annualize the figure over the expected useful life of the improvements. Calculations were performed using the New Starts' process for annualizing capital costs to determine the expected useful life differences between commuter rail, LRT, and BRT vehicles. These calculations resulted in annualization factors ranging from 0.078 to 0.083 for the various technologies. This spread of annualization factors results in an insignificant difference in annualized cost and the overall cost effectiveness.

Boardings are annualized for the four commuter rail corridors by multiplying the weekday boarding figure by an annualization factor of 300. A refinement has been made the annualization factor for the LRT/Dedicated BRT corridors. Previously, boardings in these corridors were annualization using 300 for the annualization figure. The MAG LRT sketch-planning model produces daily boarding figures, which include Saturday and Sunday service. The commuter rail sketch-planning model produces weekday boarding figures. This distinction means that an annualization factor of 365 would be more appropriate to accurately annualize the daily LRT boarding figure. The change in annualization has resulted in a proportional improvement in cost-effectiveness figures for the LRT/Dedicated BRT corridors. Given the equally proportional improvement in these cost effectiveness figures, this adjustment has not resulted in a change to the corridors contained in the Recommended High Capacity Transit Network. There is no effect upon the commuter rail cost-effectiveness figures, and given the proportional nature of the increase, there is no effect to the recommendations for inclusion of selected the commuter rail corridors in the Recommended Network.

In case of corridors identified as possibly LRT or Dedicated BRT, the LRT cost effectiveness figure has been presented.

The cost effectiveness figures presented in this report are designed as a tool to compare the corridors under consideration in the High Capacity Transit Plan. It would not be appropriate or accurate to compare these figures to other projects such as the CP/EV LRT or other transit projects which have received a certain cost effectiveness rating from the Federal Transit Administration (FTA). This measure differs significantly from the measure used in this study. The High Capacity Transit Plan cost effectiveness rating should be used only to evaluate the corridors in this report against each other.

Table 5.1-33 summarizes the results of the refined cost effectiveness calculations.

Table 5.1-33 Cost Effectiveness

Corridor	Length (miles)	Boardings per Mile	Weekday Boardings	Annual Boardings	Capital Cost per Mile	Total Cost	Annual Capital Cost	Annual Operating Cost	Revised Cost Effectiveness	Previous Cost Effectiveness
59th Ave	18.99	676	12,829	4,682,585	$38.33	$727,809,264	$58,224,741	$11,290,000	$14.85	$12.38
Bell	28.55	692	19,750	7,208,750	$38.61	$1,102,239,771	$88,179,182	$22,550,000	$15.36	$13.21
BNSF	26.18	617	16,145	4,843,500	$28.19	$737,933,062	$59,034,645	$22,550,000	$16.84	$29.17
Camelback	8.63	942	8,126	2,965,990	$40.48	$349,356,895	$27,948,552	$7,630,000	$12.00	$12.16
Central South	4.93	1,166	5,749	2,098,385	$46.25	$228,033,946	$18,242,716	$4,830,000	$11.00	n/a
Chandler Blvd.	16.45	743	12,226	4,462,490	$41.57	$683,750,317	$54,700,025	$9,740,000	$14.44	$16.51
Chandler Branch	12.6	995	12,534	4,574,910	$36.58	$460,856,044	$36,868,484	$10,440,000	$10.34	$8.57
Glendale Avenue	9.75	741	7,226	2,637,490	$44.02	$429,215,236	$34,337,219	$8,960,000	$16.42	$11.95
I-10 West	11.05	1,246	13,765	5,024,225	$36.14	$399,343,813	$31,947,505	$10,290,000	$8.41	$11.09
Main	9.64	1,006	9,697	3,539,405	$38.76	$373,625,175	$29,890,014	$8,960,000	$10.98	$13.02
Metrocenter/I-17	8.75	1,011	8,848	3,229,520	$38.59	$337,645,412	$27,011,633	$7,610,000	$10.72	$14.84
Power	13	666	8,653	3,158,345	$35.78	$465,103,053	$37,208,244	$8,260,000	$14.40	$14.95
Scottsdale Rd/Tempe Br	25.5	811	20,672	7,545,280	$39.64	$1,010,837,127	$80,866,970	$20,950,000	$13.49	$14.97
SR-51	17.34	711	12,334	4,501,910	$47.48	$823,278,568	$65,862,285	$14,340,000	$17.82	$27.09
UP Mainline/Chandler	27.95	163	4,561	1,368,300	$18.97	$530,221,490	$42,417,719	$14,250,000	$41.41	$56.96
UP Southeast	36.18	171	6,198	1,859,400	$15.69	$567,495,110	$45,399,609	$17,500,000	$33.83	$35.70
UP Yuma	30.9	389	12,034	3,610,200	$14.62	$451,799,232	$36,143,939	$22,400,000	$16.22	$27.04
Grand Avenue BRT	25.8	456	11,770	4,296,050	$9.01	$232,478,126	$18,598,250	$15,910,000	$8.03	n/a

Several corridors have improved their cost effectiveness rating dramatically since the previous review in Milestone. This shift in cost effectiveness is directly attributable to the changes in ridership estimates resulting from the revised population projections for the MAG region. However, not every corridor benefited from the revised population forecasts. Several LRT/Dedicated BRT corridors in the East Valley did not perform as well as result of lower ridership estimates. Selected LRT/Dedicated BRT corridors received worse cost-effectiveness ratings as result of the modifications made to the station catchment areas. The modification of spacing stations one mile apart resulted in lower ridership estimates across the board for LRT/Dedicated BRT corridors. This effect was mitigated on some corridors due to the increased population and estimated ridership gain. I-10 West, Metrocenter/I-17, and SR-51 were the only LRT/Dedicated BRT corridors experiencing a large enough ridership gain to overcome the effect of the revised station spacing.

The four commuter rail corridors all improved their cost effectiveness rating, but for different reasons. UP Yuma and BNSF improved due to substantial ridership increases which were capable of overcoming higher capital costs in both these corridors. Ridership gains were not as dramatic in the UP Southeast and UP Mainline/Chandler corridors. UP Southeast even experienced a reduction in projected riders from previous estimates. Instead, these corridors improved due to revisions to the number of vehicles estimated to provide commuter rail service and the resulting lower capital and operating costs.

These results make commuter rail service in the BNSF and UP Yuma corridors much more viable when compared to the other recommended corridors. The UP Southeast and UP Mainline/Chandler corridors still face challenges given the anticipated cost of implementing service. In light of these challenges a recommendation has been made to eliminate the UP Mainline/Chandler corridor from consideration for commuter rail service. It is recognized that this corridor on the UP Chandler Industrial Branch portion between Chandler and Mesa has a large level of travel demand. Given the results of the cost-effectiveness evaluation performed in this Milestone and Milestone 4 it is apparent that this demand would be best served by an LRT/Dedicated BRT corridor paralleling the UP Chandler Branch. Commuter rail demand in the corridor between Mesa and downtown Phoenix would still be served by the UP Southeast corridor. The UP Chandler Branch corridor was specifically reviewed in this analysis and received an excellent cost effectiveness rating (2nd overall). Given this performance by the LRT/Dedicated BRT technology, it is recommended that commuter rail no longer be studied for this corridor.

Despite the poor performance of the UP Southeast corridor compared to the other high capacity transit corridors contained in the recommended network, this corridor remains in consideration for high capacity transit service. This decision has been made considering the regional travel demand in the East Valley and the probable need for fast, long-distance transit service in this portion of the MAG region. Commuter rail is better suited to meeting this demand than are LRT and Dedicated BRT. Several challenges in terms of cost are faced by the UP Southeast corridor. However as shown in Section 5.1.1 above, there are alternative operating strategies and technologies which could be implemented to reduce the overall cost of building and operating commuter rail service. These alternatives are promising enough to recommend that commuter rail in the UP Southeast corridor remain in the recommended network of high capacity transit corridors.

At this point in time, this study has a limited ability to produce direct comparisons between LRT and BRT in cost-effectiveness. The MAG Sketch-Planning Model is not capable of distinguishing between LRT and BRT technologies, preventing estimates of the differences in ridership between corridors. However, using the single estimated ridership figures, it is possible to identify specific corridors that would likely perform well with Dedicated BRT service. Corridors with lower ridership figures would be prime candidates for BRT service, because the BRT technology would be capable of providing a comparable level of service at a much lower cost. Given this situation a comparison between the cost-effectiveness figures for LRT and BRT is warranted. Table 5.1-34 summarizes the cost effectiveness of both transit technologies in various corridors in the MAG region.

Table 5.1-34 **LRT-BRT Cost Effectiveness Comparison**

Corridor	LRT Annualized Cost (Capital and O&M) $ millions	BRT Annualized Cost (Capital and O&M) $ millions	LRT Cost Effectiveness	BRT Cost Effectiveness
59th Avenue	$69.51	$40.02	$14.85	$8.55
Bell Road	$110.73	$65.68	$15.36	$9.11
Camelback Road	$35.58	$20.88	$12.00	$7.04
Chandler Boulevard	$64.44	$34.22	$14.44	$7.67
Main Street	$38.85	$28.51	$10.98	$6.23
Power Road	$45.47	$38.85	$14.40	$10.98
Scottsdale Road	$101.82	$27.21	$13.49	$8.61
SR-51	$80.20	$58.23	$17.82	$7.72
Union Pacific Chandler Branch	$47.31	$34.71	$10.34	$7.71

Additional discussion comparing the capabilities of LRT and BRT is provided in Section 5.0.3. Suggested recommendations for technologies in each corridor are provided in Section 5.2.

The results of this refined evaluation of cost effectiveness will have a dramatic effect upon recommendations for phasing and timing for service in the recommended high capacity transit network. The full scope of these changes to corridor prioritization will be presented in Section 5.3.3.

Benefit Cost Analysis

This section presents the results of the simplified, sketch-planning level benefit cost analysis for 18 corridor-technology scenarios. The benefit-cost analysis results provide the means both to assess the "worth" of each project as well as to rank the projects against each other for purposes of prioritization. The scenarios are listed in Table 5.1-35.

The 18 scenarios contain all 13 potential LRT corridors. In addition, two representative corridors, Main Street and 59th Avenue, were selected for comparison between LRT and dedicated BRT technologies. These two corridors were selected for the comparison because they are representative of the diverse geographical areas of the valley.

The commuter rail corridors analyzed are the BNSF, UP Yuma and UP Southeast (all Phase 3 service levels). The UP Mainline/Chandler corridor was not included since the cost effectiveness analysis shows its potential ridership could be more effectively served by an LRT/Dedicated BRT corridor.

Table 5.1-35 **MAG High Capacity Transit Scenarios Evaluated**

Scenario Number	Corridor	Technology
1	Camelback Road	LRT
2	UP Chandler Branch	LRT
3	Main Street	LRT
4	Main Street	Dedicated BRT
5	Metrocenter/I-17	LRT
6	Glendale Avenue	LRT
7	59th Avenue	LRT
8	59th Avenue	Dedicated BRT
9	Bell Road	LRT
10	Chandler Boulevard	LRT
11	I-10 West	LRT
12	Power Road	LRT
13	Scottsdale/UP Tempe	LRT
14	SR-51	LRT

Scenario Number	Corridor	Technology
15	BNSF Phase 3	Commuter Rail
16	UP Yuma - Phase 3	Commuter Rail
17	UP Southeast - Phase 3	Commuter Rail
18	Central Avenue South	LRT

This section is organized as follows:

- The methodology used in the assessment and benefit categories are described. Definitions of key concepts are provided immediately following. Corridor rankings are shown in the tables on the subsequent pages, along with some general remarks on the findings.
- For each of the 18 scenarios the following additional information is presented in Appendix D: 1) evaluation results for project life cycle; 3) results for "steady state" year; 3) a graphical representation of the distribution of benefits over the project life cycle and 4) input data and assumptions.

Methodology

This assessment uses methodology developed by the consultant for the Federal Transit Administration. The approach rests on principles and procedures established in the following:

- The framework developed by the consultant under the agency's National Benefits Research Program for measuring the economic benefits, costs and net benefits of transit investments, (see <www.dot.fta.gov/library – Transit Benefits 2000>).
- A $2.5 million, nine-year consultant research and development engagement with the Federal Transit Administration (FTA). FTA published various reports as the findings emerged, and offered Congressional testimony by then-FTA Administrator Gordon Linton and other federal officials. The work was completed after full review and validation by external academic reviewers. That engagement, from 1991 to 2000, resulted in FTA-published methodology for measuring the effects and the economic benefits and costs of public transportation.

- The underlying estimation methodologies for each category of benefit are documented in a 1999 textbook[3] authored by Dr. David Lewis and the FTA's Dr. Fred Williams. The book is widely used in graduate-level university courses and training programs to teach the methodology and its various components. All benefit estimation methodologies have also been refereed by Urban Institute fellows and the federal Office of Management and Budget (OMB).

The methodology used in this analysis employs the benefit categories described in Table 5.1-36. The categories are most easily understood when described in terms of the different groups that benefit from the transit service.

Table 5.1-36

Taxonomy of Transit Benefit

Sources Of Benefit	Recipients Of Benefit		
	Transit Users	**Highway Users**	**Area Communities**
Mobility	Access to employment, day-care, shopping and other destinations for low income people	Greater accessibility to employment and other destinations	Reduced financial burdens on home-based and welfare-to-work social services
Community Livability and Development	Wider range of life-style choice	Time savings in local neighborhoods; more destinations accessible by walk or wheelchair	Greater range of affordable housing; Greater neighborhood diversity and social mix
Sustained Congestion Management in Major Corridors	Sustainable time savings, reliability and predictability in journeys to work and non-work places	Sustainable time savings, reliability and predictability in journeys to work and non-work places	Less pollution and greenhouse gases; Improved Safety; Reduction in sustained outlays on highway infrastructure

Definitions

1. Public Transportation Benefits

Like investment in highways, airports, and other forms of transportation infrastructure, investment in public transportation brings with it both benefits and costs. From an economic and budgetary perspective, the most desirable infrastructure investments are those whose benefits exceed their

[3] David Lewis and Fred Lawrence Williams, *Policy and Planning as Public Choice: Mass Transit in the United States,* Ashgate, 1999

total costs. The benefits of public transportation stem from its significant effect on improving people's *mobility*; its positive impact on *the economic development of the region;* and its ameliorative effects on *traffic congestion*.

Taken together, all these characteristics of public transportation make a positive contribution to the regional economy. More specifically the benefits of transit fall into three main categories that can be defined as follows:

Affordable Mobility Benefits – These are the benefits from providing low-cost mobility to lower-income households. The benefits include income from employment made possible by transit and the economic value of affordable mobility (transit fare is typically lower than taxi fare and vehicle ownership and operating cost). "Cross sector benefits" are the budget savings for welfare and social service providers due to the presence of transit and the mobility provided to their clients. Examples are savings in food stamps, home health care, and unemployment insurance.

Community Development Benefits [4] – Transit plays a vital role in neighborhoods served by high quality transit systems. The impacts of transit include lower transportation expenses (see above), changes in development patterns, and higher property values. Providing high quality transit together with development policies that allow or encourage transit-oriented development influences land use patterns toward higher densities, better pedestrian environments, and mixed-use developments clustering around transit stations. The economic literature has established that the benefits associated with transit access will be captured or "capitalized" in the price or market value of residential and commercial properties.

Congestion Management Benefits – Congestion management benefits are the savings in travel time, vehicle ownership and operating cost ("VOC:" fuel, tires, oil, etc.), environmental emissions due to less congestion, fewer miles traveled by personal vehicles due to the transit system and accidents. These savings in resources imply greater disposable household income for other purposes. The two principal sources of congestion management benefits are the reduction in travel by personal vehicles, and faster travel in less congested conditions by vehicles remaining on the roadway.

2. Time Horizons

Project Life Cycle – The horizon of the analysis is a 30-year period that begins the first year capital outlay occurs. The planning and construction of the project is assumed to last six years and revenue service commences in the Year 7. After a four-year ramp-up period, steady state ridership is

[4] This type of benefit is mainly found in corridors with rail transit systems as opposed to bus lines.

achieved in the fifth year of service (Year 11). Ridership continues at an assumed normal growth rate through the end of the 30-year life cycle. The life of rail rolling stock is approximately 30 years, while the typical transit bus needs replacement after 12 years. Costs for replacement of buses are included in the two BRT scenarios.

It is important to analyze the project life cycle as a whole in order to completely capture all the costs and benefits. Discounted cash flow calculations which yield a present value (see below) are a means to express the life cycle costs and benefits over a period of many years from the perspective of a single year.

Steady State Year –After service has begun it will take several years for new riders to become familiar with the new service and for established travel patterns to change. This introductory period is called the "ramp-up" period, assumed to be four years in this analysis. A representative year after the end of ramp-up is called the steady-state year. In order to obtain a perspective of a project's viability over the long term, it is useful to look at the relationship of benefits and costs after the initial large capital outlays are completed and once ridership has attained steady state levels.

3. Assessment Criteria

The assessment is based on four criteria that measure project worth and timing. These four criteria are shown in Table 5.1-37.

Table 5.1-37 **Benefit Cost Analysis Investment Evaluation Criteria**

Investment Evaluation Criteria	Description	Threshold Level
Net Present Value (NPV)	The discounted present value of total benefits minus the discounted present value of total costs.	Greater than zero
Benefit-Cost Ratio (B/C)	The discounted present value of total benefits divided by the discounted present value of total costs.	Greater than 1
Internal Rate of Return (IRR)	The rate of return from a stream of annual discounted net benefits.	Greater than the opportunity costs of money
Payback Period (PP)	The number of years required to recover the costs from the stream of benefits.	Shorter than the project life cycle

Net Present Value – Discounted cash flow calculations are a technique to represent a stream of costs or benefits over a multi-year period as a single dollar amount from the perspective of a single point in time. Benefits or costs occurring far in the future are worth less that those occurring now or in the near future. A discount rate (four percent after inflation in this analysis) is used to reduce the value of a dollar of benefit or cost for each year into the future that benefit or cost will occur. Major transit projects entail a significant capital outlay in the early years of the project, while benefits and operating revenues are generated in smaller amounts over a longer period of years later in the project life cycle.

This report presents the sum of the present values of total benefits and the present value of total costs for each scenario. The *net* present value is the present value of benefits less the present value of the costs. In this way, multiple scenarios can be compared and evaluated on a level playing field, even if the pattern and magnitude of costs and benefits differ among scenarios. Scenarios generating higher net present values are more attractive investments than scenarios whose net present value is lower.

Benefit-Cost Ratio – In order to prevent a bias toward larger investments, the *ratio* between the benefit and the cost can be a more effective indicator of project performance than the net present value. Table 5-1.37 ranks the 18 scenarios by benefit-cost ratio.

Internal Rate of Return – The discount rate required to force the net present value to zero is called the internal rate of return. It is another commonly-applied statistic to evaluate several projects. The internal rate of return has the additional advantage in that it can be compared to the rate of return on low risk investment instruments such as treasury bonds. If the internal rate of return is positive, but lower than what an investor could obtain in the market place, the project may not a worthwhile investment.

Payback Period – The number of years it will take to recoup the cost of a project from its revenues and benefits is called the payback period. A shorter payback period means that the initial capital outlay is recovered more quickly. Generally speaking, an investment with a shorter payback period is more attractive when compared to a project with a longer payback period.

Results

Summary results are shown in Table 5.1-38. The four overall evaluation measures are net present value, benefit cost ratio, internal rate of return and payback period. Table 5.1-38 ranks the scenarios by benefit-cost ratio. The benefit-cost ratio is probably the best single evaluation metric to use because it is easiest for the non-technical audience to grasp and does not bias the results toward larger investments as does the net present value.

The overall evaluation figures presented in Table 5.1-38 are mean values. The benefit cost methodology includes a risk analysis that presents results as the distribution of outcomes. Risk analysis helps avoid the lack of perspective in "high" and "low" forecast cases by measuring the probability or "odds" that an outcome will actually materialize. This is accomplished by attaching ranges (probability distributions) to the forecasts of each input variable as appropriate. The approach allows all inputs to be varied simultaneously within their distributions, thus avoiding the problems inherent in conventional sensitivity analysis. The approach also recognizes interrelationships between variables and their associated probability distributions.

The detailed tables for each scenario in Appendix D show the boundaries of an 80 percent confidence interval ("lower 10 percent" and "upper 10 percent") for both inputs ("assumptions") and outputs. Ranges for a majority of input variables have been supplied by the consultant team based on its experience in performing benefit cost analysis for transportation investments. The outputs of the process are expressed as probability distributions in a similar way.

Table 5.1-38 **MAG High Capacity Transit Project Life Cycle Evaluation Measures (Ranked by Benefit-Cost Ratio)**

Benefit-Cost Rank	Scenario Number	Corridor	Technology	Mean Values			
				Net Present Value (Millions of 2001 $)	Benefit-Cost Ratio	Internal Rate of Return, %	Payback Period, years
1	16	UP Yuma - Phase 3	Commuter Rail	$ 2,223.0	4.19	18.26%	7
2	11	I-10 West	LRT	$ 799.3	2.64	12.49%	9
3	14	SR-51	LRT	$ 1,177.9	2.28	10.38%	12
4	8	59th Avenue	Dedicated BRT	$ 479.3	2.04	9.75%	13
5	5	Metrocenter/I-17	LRT	$ 344.6	1.87	9.09%	13
6	9	Bell Road	LRT	$ 947.4	1.75	8.38%	14
7	15	BNSF Phase 3	Commuter Rail	$ 652.4	1.69	7.91%	16
8	13	Scottsdale/UP Tempe	LRT	$ 711.4	1.61	7.79%	15
9	7	59th Avenue	LRT	$ 310.9	1.39	6.29%	18
10	1	Camelback Road	LRT	$ 126.1	1.31	5.93%	19
11	17	UP Southeast - Phase 3	Commuter Rail	$ 224.4	1.30	5.46%	20
12	4	Main Street	Dedicated BRT	$ 25.5	1.11	4.82%	20
13	6	Glendale Avenue	LRT	$ 27.3	1.05	4.21%	21
14	10	Chandler Boulevard	LRT	$ (19.6)	0.97	3.67%	22
15	2	UP Chandler Branch	LRT	$ (23.3)	0.96	3.46%	22
16	3	Main Street	LRT	$ (96.0)	0.78	1.63%	23
17	12	Power Road	LRT	$ (146.6)	0.72	1.10%	23

Benefit-Cost Rank	Scenario Number	Corridor	Technology	Mean Values: Net Present Value (Millions of 2001 $)	Mean Values: Benefit-Cost Ratio	Mean Values: Internal Rate of Return, %	Mean Values: Payback Period, years
18	18	Central Avenue South	LRT	$ (168.6)	0.50	-3.82%	23

Notes: All benefits and costs are in Year 2001 dollars, with a 4% real discount rate

Remarks

The benefit-cost analysis, like the cost effectiveness calculation, reflects the relationship between ridership and costs within each scenario. However, it is important to recognize that the key additional factor at work in the benefit-cost analysis is the level of roadway congestion forecast for the competing arterial or freeway segment. Transit services competing against roadways that are highly congested will generate high levels of travel time and vehicle operating cost savings. These congestion management benefits constitute a large proportion of the total project benefits in the highest ranked corridors above. Conversely, congestion management benefits from new transit services are lower both in absolute and relative terms in scenarios where roadway congestion will be minor. The results of the benefit-cost analysis could change based on the run of the MAG travel demand model if it is determined that revised congestion levels are markedly different from those assumed in this analysis.

There is considerable variation in results among the scenarios. The benefit-cost ratio ranges from 4.19 in the case of the UP Yuma commuter rail scenario to 0.50 for the Central Avenue South LRT line. Five of the 18 scenarios generate costs in excess of benefits.

As a group, the commuter rail corridors show positive results due in part to the strong ridership forecasts for the West Valley lines. A significant contributing factor is the higher diversion rate from autos that was assumed. In addition, the longer length of the commuter rail corridors compared to the others tends to increase the relative congestion management benefits generated. On the other hand, the commuter corridors exhibit lower benefits in the low income mobility and livable community categories since a lower percentage of commuter rail riders belong to low income groups.

The strong performance of UP Yuma and the other commuter rail corridors is magnified by the assumed diversion rate of 75 percent from autos compared to 50 percent for LRT and BRT scenarios. As a rule, commuter rail services tend to divert a greater proportion of trips from autos than LRT and BRT services. Commuter rail can be considered a “premium” service compared to the other technologies due to factors such as longer spacing between stations, higher line haul speeds, and more spacious seating.

When compared to LRT and BRT, commuter rail often captures a higher proportion of home to work trips occurring during congested peak hours. These are the times of the day when the competitive advantage of transit is greatest.

The primary reason that the UP Yuma scenario in particular generates benefits of such magnitude is the extremely high level of congestion on the competing highway corridor, I-10. In 2040 it is forecast to take more than 6.5 times as long to travel the length of the corridor at peak times than during free flow conditions.

The high level of congestion on I-10 is also the major cause of the high ranking for Scenario 11, I-10 West LRT. High levels of roadway congestion are a significant factor in the high ranking of the SR-51 scenario as well. The results for the UP Yuma, I-10 West, and SR-51 are higher than are typically seen in the consultant team's analyses of similar projects.

The lower relative costs of the BRT scenarios compared to their LRT counterparts cause them to score higher given that ridership is the same for both technologies. This outcome occurs in spite of the smaller community development benefits generated by BRT: the development impact area for BRT encompasses a 0.25-mile radius while a 0.5-mile radius is assumed for LRT. Emissions benefits are significantly lower for BRT as compared to LRT, and in fact both BRT scenarios generate a negative benefit in the emissions category. The one caveat to this result is the expected lower ridership levels that would be generated by a BRT system when compared to an LRT system. This difference in ridership levels would likely result in a reduction in the advantage BRT has over LRT.

5.2 MAG Region High Capacity Transit Network

This section describes the recommended network of high capacity transit corridors for the MAG region. Detailed descriptions are provided for each corridor along with a discussion of the linkages between the network of high capacity transit corridors and the future Valley Metro bus network.

5.2.1 The Recommended High Capacity Transit Network

The evaluation process conducted in Milestone 4 resulted in the identification of a preliminary network of high capacity transit corridors serving the MAG region. Originally, 28 corridors were identified for possible inclusion in the high capacity network. A detailed evaluation process was undertaken in Milestone 4 to select high capacity transit network.

The Milestone 4 evaluation process resulted in the advancement of 13 LRT/Dedicated BRT corridors and four commuter rail corridors for inclusion in the recommended high-capacity transit network. The LRT/Dedicated BRT corridors were placed into two groups at the end of Milestone 4 based upon their overall cost-effectiveness and benefit provided to the regional transportation network:

Group A:

- 59th Avenue
- Camelback Road
- Union Pacific Chandler Branch
- Metrocenter/I-17
- Northern Avenue (changed to Glendale Avenue in future analysis)
- I-10 West

Group B:

- Bell Road
- Chandler Boulevard
- Main Street
- Power Road
- Scottsdale Road/Rural Road
- SR-51

- Union Pacific Tempe Branch
- Burlington Northern Santa Fe (BNSF)
- Union Pacific Mainline/Chandler
- Union Pacific Southeast
- Union Pacific Yuma

Recommended High Capacity Transit Network

After refining the ridership and cost estimates in Section 5.1, consulting with local agency representatives, and reviewing the overall proposed network, several refinements were made to the recommended high capacity transit network. The recommended network now consists of 15 corridors, three commuter rail corridors and 12 LRT/Dedicated BRT corridors. Exhibit 5.2-1 illustrates these corridors and their coverage of the MAG region. Preliminary operating characteristics of each corridor are explained below.

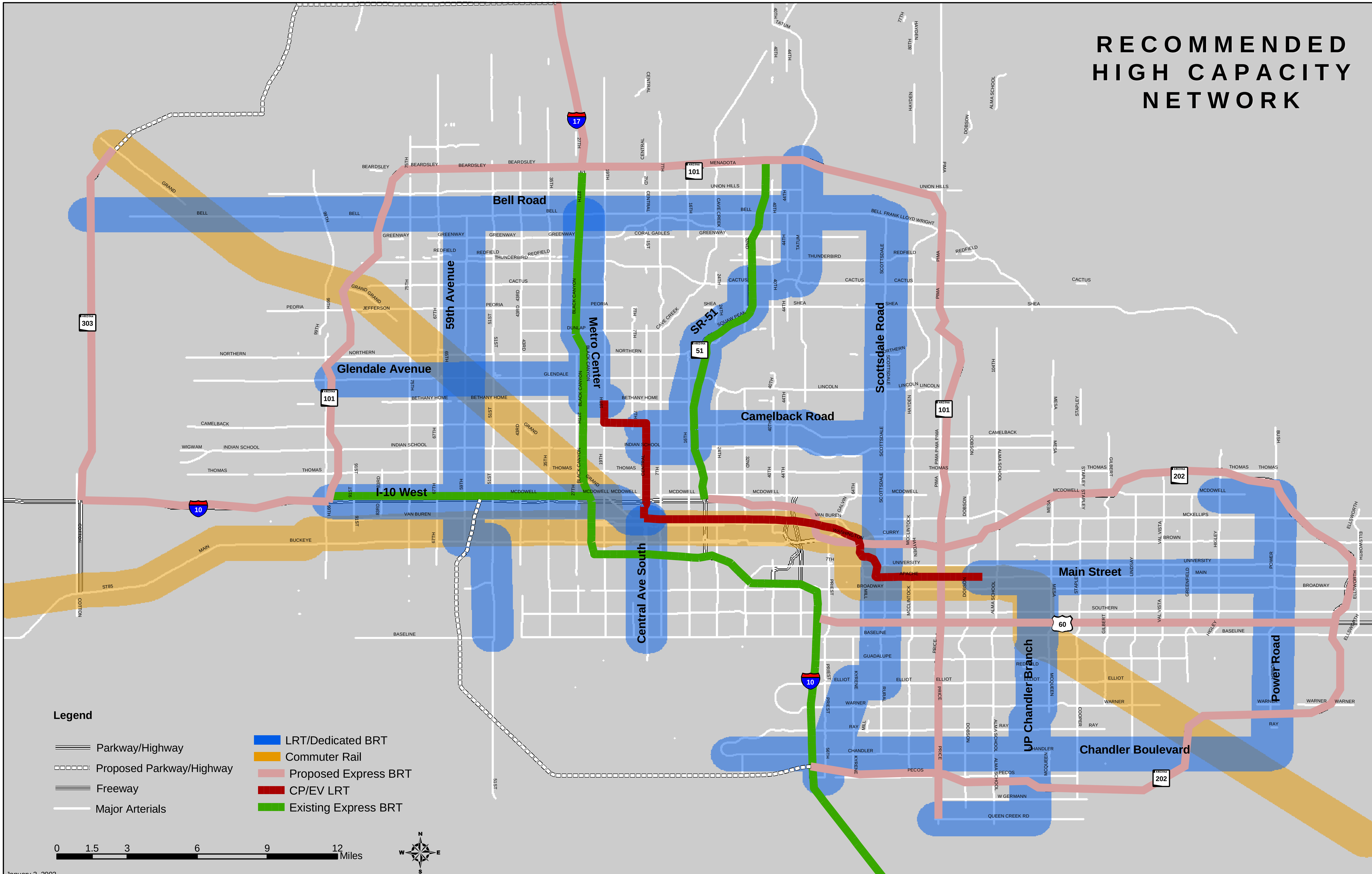
Refinements have been made to several of the high capacity transit corridors since the conclusion of the Milestone 4 evaluation process. These refinements include adjustments to the limits of corridors, specific alignments, and headways or frequency of service. The specific refinements preformed are described Section 5.2.2.

Table 5.2-1 summarizes the 15 corridors and their proposed technologies.

Table 5.2-1 **Potential High Capacity Transit Corridors & Technologies**

Corridor	Limits	Technology
59th Avenue	51st Avenue/Baseline Road to 59th Avenue/Bell Road	LRT/Dedicated BRT
Bell Road	Loop 303 to Scottsdale Road	LRT/Dedicated BRT
Burlington Northern Santa Fe (BNSF)	Downtown Phoenix to Loop 303	Commuter Rail
Camelback Road	Loop 101 West Valley to Scottsdale Road	LRT/Dedicated BRT
Chandler Boulevard	Ray Road to Power Road	LRT/Dedicated BRT
Union Pacific Chandler Branch	Union Pacific Mainline to Queen Creek Road and Price Road	LRT/Dedicated BRT
Glendale Avenue	Glendale/19th Avenue to Bell Road/Scottsdale via SR-51, Cactus, Tatum	LRT/Dedicated BRT

Corridor	Limits	Technology
Interstate 10 West	Central Avenue/Van Buren to Loop 101	LRT
Main Street	Alma School Road to Power Road	LRT/Dedicated BRT
Metrocenter/I-17	19th Avenue/Bethany Home to I-17/Peoria	LRT
Power Road	Williams Field to Higley Road/McDowell Road	LRT/Dedicated BRT
Scottsdale Road/UP Tempe Branch	Queen Creek Road/Price Road to Scottsdale/Bell	LRT/Dedicated BRT
SR-51	Glendale Avenue/19th Avenue to Tatum Blvd./Loop 101 via Tatum north of Cactus	LRT/Dedicated BRT
Union Pacific Southeast	Downtown Phoenix to Ellsworth Avenue	Commuter Rail
Union Pacific Yuma	Downtown Phoenix to Buckeye	Commuter Rail



RECOMMENDED HIGH CAPACITY NETWORK
Bell Road
Glendale Avenue
59th Avenue
Metro Center
SR-51
Camelback Road
Scottsdale Road
I-10 West
Central Ave South
Main Street
UP Chandler Branch
Chandler Boulevard
Power Road
Legend
Parkway/Highway
Proposed Parkway/Highway
Freeway
Major Arterials
LRT/Dedicated BRT
Commuter Rail
Proposed Express BRT
CP/EV LRT
Existing Express BRT
0
1.5
3
6
9
12
Miles
N
S
E
W
January 3, 2003
Network Map - Wide Corridors

5.2.2 Detailed Corridor Descriptions

The corridor identification process undertaken in Milestone 3 provided detailed descriptions of each corridor including land use, traffic congestion, the proposed corridor limits, and proposed technologies. During the evaluation and refinement of these corridors, several modifications have been made to various corridors as a result of the ridership and cost estimates, input from local agencies, and an analysis of the overall linkages between corridors in the recommended network. Refined detail corridor descriptions are included below for each of the 15 recommended high capacity transit corridors. These descriptions include information about the corridor setting and conditions as well as descriptions and justifications for the proposed service in terms of headways and technology.

The corridors identified below are five miles in width and could include a combination of several alignments within this five-mile wide area. The corridor names used in this report are labels used to identify the corridors and act as centerline alignments for the development of ridership forecasts and cost estimates. Population density figures cited under these descriptions were obtained from the MAG Draft 2 Population Projections within one mile on either side of the particular corridor.

59th Avenue

Modifications & Refinements

59th Avenue has not been modified from its proposed configuration of running from 51st Avenue and Baseline Road in southern Phoenix to 59th Avenue and Bell Road in Glendale. The corridor could be refined in future detailed studies to connect with the UP Yuma commuter rail line in West Phoenix at either 51st Avenue or 59th Avenue.

Major Activity Centers

The proposed 59th Avenue transit corridor passes numerous minor activity centers from its northern terminus at Bell Road to its southern terminus at 51st Avenue and Baseline Road. Activity centers along the corridor include the Glendale Galleria, on Peoria Avenue, Glendale Community College at Olive Avenue, the Manistee Town Center on Northern Avenue, and downtown Glendale. The corridor passes just west of Maryvale Stadium, located along Osborn Road.

Downtown Glendale near 59th Avenue

Future Population Density and Development Patterns

The average population density of the 59th Avenue Corridor is approximately 7,360 with a total population of just under 140,000 within one mile of 59th Avenue. This is relatively moderate in comparison to the other corridor alternatives. The highest density occurs along the southern segment of the corridor, adjacent to Interstate 10.

Connections to Other High Capacity Transit Corridors

The major connection point between corridors on the 59th Avenue corridor is in downtown Glendale where 59th Avenue, Glendale Avenue, and the BNSF corridor converge. This transfer center could become a connection point for commuters in the West Valley and could be a major ridership generator for each of the three corridors. I-10 West will be an important connection point for riders traveling between southwestern Phoenix and downtown Phoenix. An additional connection is also provided at Bell Road at the north end of the corridor.

Service Parameters

High capacity transit service in this corridor will be similar to others in the western portion of the MAG region. Headways are assumed to be 15 minutes in the peak, resulting from the slightly lower ridership projections on this corridor compared to others in the West Valley. Overall, ridership projections for the 59th Avenue corridor compare well to the other recommended corridors. Both LRT and Dedicated BRT service would be fully capable of serving these projected riders. Further cost and alignment refinements during a detailed corridor study would determine the technology most appropriate for this corridor. Additional consideration would also be given to the interfacing of this corridor with major east-west corridors such as I-10 West and Glendale where interlining between corridors could drive the technology selection process.

Bell Road

Modifications & Refinements

No modifications were made to the Bell Road corridor. This corridor still serves the northern portion of the MAG region between Loop 303 in the west and Scottsdale Road in the east.

Major Activity Centers

The Bell Road Corridor has several existing activity centers along its route. In the City of Surprise, there is the Crossroads Towne Center. The North Valley Power Center, Arrowhead Crossing, and Arrowhead Towne Center are major activity centers along the corridor in Peoria, located along Bell Road between 83rd Avenue and 75th Avenue. Peoria Stadium, used for major

The Scottsdale Airpark is a developing activity center in the Bell Road corridor league baseball spring training games, is located just south of Bell Road along 83rd Avenue. The Scottsdale Airport will be a major destination point, anchoring the eastern most terminus of the corridor.

Future Population Density and Development Patterns

On average, the Bell Road corridor has a population density of approximately 16,200 people per mile. The population density pattern indicates relatively consistent development patterns throughout most of the corridor, with the highest density occurring near 7th Street.

Connections to Other High Capacity Transit Corridors

With its long length, the Bell Road corridor connects to several other corridors in the recommended high capacity transit network. Connections in the West Valley occur with the BNSF commuter rail corridor and 59th Avenue. The BNSF commuter rail station at Bell Road serves a large number of passengers, many of whom will likely access the station via a high capacity transit system on Bell Road. Additional connections are provided at I-17, SR-51, and Scottsdale Road. As noted in earlier Milestones many of trips originating in the Bell Road corridor remain in the corridor; however, the remaining trips are likely destined to points south of Bell Road, making these multiple connections to north-south corridors essential to improving transit mobility in the northern MAG region.

Service Parameters

Bell Road is proposed to run with 10 minute headways, which coordinate with the other LRT/Dedicated BRT corridors connecting with the corridor at various points. The only mismatch in headways will occur at the BNSF transfer point. However, with a 15 minute headways provided for full service commuter rail, there would be a short five minute wait for a train at the Bell Road station. The ridership levels for this corridor would likely support either LRT or BRT service. A detailed corridor study would be to determine the most appropriate technology.

BNSF

The BNSF corridor serves the northwestern MAG region with an alignment that travels diagonally through the established street grid pattern. The limited number of existing parallel corridors increases the importance of this corridor and reduces competition between modes.

Modifications & Refinements

The BNSF corridor originally extended from downtown Phoenix to Bell Road in Surprise. In light of the revised population forecasts for the City of

Surprise and the strong ridership demand in this portion of the corridor, a second station was added at Loop 303 and BNSF railway. This brings the overall corridor length to 26.18 miles. This is slightly shorter than what was report in Milestone 4, due to a correction of an error in the corridor length between Bell Road and downtown Phoenix. Stations are located at North Surprise, South Surprise, Peoria, Glendale, and East Glendale/West Phoenix.

The Grand Avenue corridor parallels the BNSF line and experiences a high level of traffic congestion

Major Activity Centers

The proposed BNSF commuter rail corridor would serve several major activity centers in the region. These include downtown Phoenix, the Arizona State Fairgrounds and downtown Glendale. In Peoria, centers that would be served include the Civic Center and Peoria Town Center and in Surprise, the Crossroads Towne Center.

Future Population Density and Development Patterns

The BNSF Commuter Corridor has one of the lowest population density patterns of the corridor alternatives, with approximately 20,000 people per mile, when compared to a total population within the corridor of almost 535,000. Commuter rail is more suited to serve lower density corridors given the typically larger station catchment areas.

Connections to Other High Capacity Transit Corridors

The BNSF corridor links to two other high capacity transit corridors prior to entering downtown Phoenix. The Bell Road corridor provides a link at the northern portion of the MAG region, while the connection to Glendale Avenue and 59th Avenue in Glendale links the BNSF corridor to most of the West Valley. This connection point would become a major hub for commuters in Glendale and western Phoenix to travel anywhere in the MAG region. Additional connections would be available in downtown Phoenix to the CP/EV LRT, I-10 West and the Central Avenue LRT as well as the UP Southeast and the UP Yuma commuter rail corridor.

The Grand Ave/Loop 303 station area is forecast to experience rapid growth during the next 40 years

Service Parameters

Service on the BNSF corridor would be implemented in two main phases. Phase 1 is the beginning level of service with trains running in a single direction during peak periods only. Phase 3 service is the full operation of commuter rail service with 15 minute headways during the peak period, reverse commute service and frequent off-peak service as well. There would be incremental steps to implementing Phase 3 service; these steps would be taken depending upon ridership growth and funding availability. Phasing is discussed more in Section 5.3.

Camelback Road

The Camelback Road corridor was one of best performing corridors in terms of boarding per mile in the Milestone 4 evaluation and the revised ridership estimates produced in this report. However, the existing density of land uses in this corridor present several challenges to the cost-effective implementation of high capacity transit service in this corridor. As originally proposed, this corridor was 19 miles in length and extended from Loop 101 in the West Valley to Scottsdale Road on the east.

Modifications & Refinements

In light of the implementation challenges present and the proximity of this corridor to the Northern Avenue (Glendale Avenue) corridor west of I-17, a modification was made to this corridor to reduce the overall length from 19 miles to 8.63 miles. Northern Avenue and Camelback Road are within three miles of each other, creating a possible overlap in catchment areas, particularly if the alignments change to run on parallel streets such as Bethany Home or Glendale Avenue. As a result, the Camelback Road corridor and the Northern Avenue corridor were consolidated into a single corridor on Glendale Avenue between I-17 and Loop 101 in the West Valley. The new limits of this corridor are Central Avenue in the west and Scottsdale Road in the east. Service west of Central Avenue would follow the CP/EV line to Glendale Avenue and then continue west. The new Camelback Road alignment concentrates its service in a very dense and congested east-west corridor linking downtown Phoenix and downtown Scottsdale.

Major Activity Centers

The Camelback/24th Street area is major activity center in the Camelback corridor

The modified Camelback Road corridor serves several activity centers along its 8.63 mile route. The major activity center in the western portion of the route is the Biltmore Fashion Park and its surrounding hotels and retail areas. Pedestrian activity in this area is high, creating a strong market for transit services. The second major activity center in the Camelback corridor is Downtown Scottsdale. This activity center anchors the eastern terminus of the corridor and provides a strong destination point for trips originating in the Camelback corridor and in the CP/EV corridor.

Future Population Density and Development Patterns

The population density along the Camelback Road corridor is around 7,200 people per mile, with the highest concentration of people along the western segment of the corridor, roughly two miles north of the Phoenix Civic Center. On average, the density along the corridor is relatively high in comparison to the other proposed corridors.

Connections to Other High Capacity Transit Corridors

The Camelback corridor provides an important east-west link between two major employment centers and two high-capacity transit corridors, which run north-south through the employment centers. At the western end of this corridor is Central Avenue and the CP/EV serving downtown Phoenix. Downtown Scottsdale and the Scottsdale Road corridor mark the eastern end of the Camelback corridor. These two links are important in that they allow north-south connection points for residents of this dense corridor.

Service Parameters

Service along the Camelback corridor would incorporate frequent headways of 5 to 10 minutes during peak periods. No preferred technology has been selected for this corridor based upon ridership levels. Instead, the technology and alignment selection could be based on capital cost and other factors as appropriate. Camelback is a dense and established corridor with limited space for the construction of new transportation infrastructure. High capacity transit within this corridor will need the flexibility to serve parallel alignments while minimizing the impacts to existing development.

Central Avenue South

The Central Avenue South corridor is a southern extension of the CP/EV LRT system extending from Jefferson and Washington Streets in downtown Phoenix to Baseline Road, and is a new corridor placed into the refined evaluation process contained in this report. This corridor is already planned for implementation as a Dedicated BRT corridor by the City of Phoenix. An additional analysis of this corridor is being conducted in the High Capacity Transit Plan to determine if light rail is an appropriate technology for this corridor.

Modifications & Refinements

This corridor was not previously evaluated as part of the Network 1 and Network 2 alternatives developed in Milestones 3 and 4. The implementation of BRT service in the corridor is assumed to be part of the baseline high capacity transit network. Future service considerations and population growth forecasts for the southern portions of Phoenix have created a situation where it is appropriate to analyze this corridor as a possible LRT corridor.

Major Activity Centers

The major activity and employment center in the Central Avenue South corridor is downtown Phoenix. The downtown Phoenix area is a major employment center in the MAG region and is home to several major activity centers and trip generators including Bank One Ballpark, America West Arena, and the Phoenix Civic Plaza. The southern portions of the corridor are primarily residential.

Future Population Density and Development Patterns

The Central Avenue South corridor supports a very dense residential development base near the southern end of the corridor with an average density of 9,000 per mile along the corridor. This residential area generates a substantial number of trips to the downtown Phoenix area. The northern portions of the corridor consist of industrial development south of the Union Pacific freight railroad line and dense commercial office, entertainment, and sports recreation uses north of the rail line in downtown Phoenix.

Connections to Other High Capacity Transit Corridors

There are several potential links to other high capacity transit corridors in downtown Phoenix. The major linkage will be with the CP/EV LRT near Jefferson and Washington Streets. Additional linkages could be made with the I-10 West corridor, the SR-51 corridor, and the three commuter rail corridors. These connections would provide linkage and access to the West and Eats Valley as well as northern portions of the MAG region.

Service Parameters

Should this corridor be converted to an LRT corridor, there are several options for linking LRT service on Central Avenue South to the CP/EV LRT and other potential LRT corridors in downtown Phoenix. The most basic implementation would be to operate the service as an exclusive line that requires a transfer to the CP/EV LRT and other light rail corridors in downtown Phoenix, perhaps near the station planned for the Central Avenue Bus Terminal. More complex options involve interlining this corridor with the CP/EV LRT or one of the other potential LRT corridors serving downtown Phoenix including I-10 West or SR-51. This scenario could result in higher ridership figures as detailed in Table 5.1-x in Section 5.1.1. Future corridor analysis studies will near to determine the best way to link these multiple services.

Chandler Boulevard

Modifications & Refinements

The Chandler Boulevard corridor has not been modified during the identification of the recommended high capacity transit network. This corridor still extends from Ray Road in the west to Power Road in the east, serving southern Chandler and Gilbert.

Major Activity Centers

The Chandler Boulevard corridor serves several existing and planned activity centers within and adjacent to the City of Chandler. The Plaza at Mountainside is located towards the western terminus of the corridor at Chandler Boulevard and Mountain Parkway. Another activity center that currently exists is the Chandler Fashion Center, which is located along Chandler Boulevard at the Price Freeway (Loop 101). The Chandler-Gilbert Community College is located just south of Chandler Boulevard off of Gilbert Street. The eastern terminus of the corridor is adjacent to East Campus of Arizona State University, at the intersection of Chandler Boulevard and Power Road and the Williams Gateway Airport. A future center for activity at this location will be the Williams Gateway, which will be a large employment center consisting of commercial and research developments.

Future Population Density and Development Patterns

The Chandler Boulevard Corridor has a relatively low population density of roughly 9,706 people per mile, taking into consideration a population of approximately 160,000. This density pattern is typical with a suburban development pattern. However, given the existing high travel demand, the corridor would be capable of supporting high capacity transit service.

Connections to Other High Capacity Transit Corridors

Williams Gateway Airport is a major component of the Williams Gateway area

There are three north-south high capacity transit corridors which provide connections to the Chandler Boulevard corridor and link this corridor with major activity centers in Mesa and Tempe. Scottsdale Road/UP Tempe Branch, UP Chandler Branch and Power Road are the three LRT/Dedicated BRT corridors linking with Chandler Boulevard. The spacing of these links allows for convenient connections to north-south corridors from any point along the Chandler Boulevard corridor. Additionally, the UP Southeast corridor links to Chandler Boulevard near Williams Gateway. This station transfer area would be a major destination and transfer point in the East Valley with the convergence of three corridors, Chandler Boulevard, Power Road and UP Southeast.

Service Parameters

The Chandler Boulevard corridor is proposed to provide headways of approximately 15 minutes in the peak period. This figure is higher than some of the other LRT/Dedicated BRT corridors located in the more central areas of the MAG region. Overall the population and employment densities in this corridor are lower than other corridors included in the recommended network, meaning that the frequency of service could be lower and still be capable of meeting projected demand. Ridership estimates support the selection of slightly longer headways in this corridor. Both LRT and BRT technologies would be capable of serving the ridership projected in this high capacity transit corridor. BRT may be more suitable since it would be capable of providing similar service to LRT in corridor given estimated ridership. In addition, the lower capital cost would likely make service more cost effective.

Glendale Avenue (Northern Avenue)

This corridor is a new corridor created from a consolidation of the Northern Avenue corridor and the western portion of the Camelback Avenue corridor. The original limits of this corridor extended from 19th Avenue to Grand Avenue along Northern Avenue. At the conclusion of Milestone 4 it was determined that the proposed sports, entertainment, and commercial project planned near the Glendale Avenue/Loop 101 interchange would serve as a major generator of ridership and travel demand. A modification was made to extend this corridor beyond Grand Avenue to Loop 101 in order to serve this new major activity center.

Modifications & Refinements

As noted above this corridor was originally centered on Northern Avenue, but the centerline was shifted south to Glendale Avenue as a result of two factors. The first factor was the proximity of Northern Avenue and Camelback Road, competition between these two corridors was eliminated by consolidating them. A second factor is the presence of the new entertainment, sports, commercial, and retail development at Loop 101 and Glendale Avenue. A corridor centered on Glendale Avenue would serve this emerging destination point better than a corridor on Northern Avenue would.

The Phoenix Coyotes' Arena will be a major activity center in the Glendale Avenue corridor

Major Activity Centers

Two major activity centers exist in this corridor. The existing activity center is Downtown Glendale, a major focal point for employment for the northwest MAG region. The Glendale Sports and Entertainment Complex is the other major activity center, which will be developing over the next decade. This facility will be home to a new professional arena, a new professional football stadium, a major mixed-use commercial office, entertainment and retail facility, and new residential development.

Future Population Density and Development Patterns

On average, the population density along the Glendale Avenue corridor is around 7,900 people per mile. The highest concentration of people is located along the eastern segment of the corridor, near Interstate 17. The density along the corridor is distributed relatively even in comparison to the other proposed corridors. This indicates a consistently medium density development pattern along much of the corridor.

Connections to Other High Capacity Transit Corridors

The Glendale Avenue corridor provides connections with two other high capacity transit services. The first is provided at the eastern terminus of the corridor, where a connection is made with the Metrocenter/I-17 corridor. This connection provides a vital link to the Interstate 17 corridor and to the CP/EV LRT line to downtown Phoenix.

The second connection is provided in downtown Glendale where Glendale Avenue, 59th Avenue and the BNSF corridor intersect. This connection provides an interface point for three major high capacity transit services at a major activity center, making this a likely location for a major transfer station for high capacity transit in the western MAG region.

Service Parameters

Given the importance of the connections provided to other high capacity transit services, frequent service will need to be provided. The proposed service should allow for efficient transfers between the transit systems. As a result of a recent ballot measure, this corridor will likely utilize LRT technology.

I-10 West

This corridor serves the highly congested alignment of I-10 between Loop 101 and downtown Phoenix. This already congested corridor will require capacity improvements through transit service in order to accommodate the future demand generated by population increases in the southern MAG region.

Modifications & Refinements

No modifications were made to the proposed alignment or limits of the I-10 West corridor. The corridor still extends from downtown Phoenix to Loop 101 West. In the revisions to Milestone 4, this corridor was assumed to operate at-grade. This assumption has been retained in this report.

Major Activity Centers

There are two major activity centers within this corridor. The first is downtown Phoenix, which is a major employment center for the region. Downtown Phoenix will serve as the eastern terminus of this corridor. The second activity center for the corridor is the Desert Sky Mall, located just north of Interstate 10 along 75th Avenue at the intersection with West Thomas Road. This destination point is becoming a major transit hub for local and express bus service. New LRT service in this corridor would potentially strengthen the importance of the transit hub in this area.

Future Population Density and Development Patterns

Population density is about average, 8,000 per mile, in comparison to the other corridors being proposed. This high density can be attributed to the development pattern of downtown Phoenix. The eastern portion of the corridor consists of much more densely developed land use patterns. In the west, the development pattern becomes more suburban, but still relatively dense.

Connections to Other High Capacity Transit Corridors

The I-10 West Corridor feeds directly into the CP/EV LRT system in downtown Phoenix. This provides a connection for the West Valley Cities to activity and employment centers in Phoenix, Tempe and Mesa. A second connection is provided at 59th Avenue linking the I-10 West corridor with southern Phoenix and Glendale.

The I-10 LRT could be located in the freeway median.

Service Parameters

The I-10 West corridor experiences the highest per mile boardings of the 15 recommended corridors. This creates the need for frequent service, particularly during peak periods when congestion on I-10 is highest. Based upon the outlines of the MAG Long Range Transportation Plan and the City of Phoenix Long Range Plan, this corridor would utilize LRT technology. This technology will likely be warranted based on the estimated ridership levels.

Main Street

The Main Street corridor will be the eastern extension of high capacity transit service beyond the terminus of the CP/EV. This extension will serve downtown Mesa and the surrounding residential development.

Modifications & Refinements

No changes have been made to the limits of the Main Street Corridor. The western terminus of the corridor remains at the terminus of the CP/EV alignment near Alma School Road. The eastern terminus of the corridor remains at Power Road.

Downtown Mesa will be a focal point for Main Street ridership

Major Activity Centers

Several activity centers are located within this proposed corridor. The major employment destination for the corridor is downtown Mesa. Additional retail malls and establishments along the corridor would also attract riders.

Future Population Density and Development Patterns

For the Main Street corridor, population density is high, approximately 9,500 per mile, in comparison to the other corridors being proposed. This is related to the consistent medium density development pattern that occurs along the majority of the corridor length, with the highest density occurring along the center portion of the corridor.

Connections to Other High Capacity Transit Corridors

The Main Street corridor provides connections with four other high capacity transit services. This allows for direct connections to major employment centers in the East Valley. The CP/EV LRT provides a connection from Main Street to ASU and Tempe. Power Road and the UP Southeast Commuter rail corridor provide connections to Williams Gateway, and the UP Chandler Branch, which connects to the Chandler High Technology corridor at its southern terminus.

Service Parameters

High Capacity Transit Service along Main Street will be closely coordinated with the service provided on the CP/EV LRT system. Main Street will serve as an extension of this corridor, providing service not only within the 9.5-mile limits identified in this network, but also trips destined for Tempe/ASU and Phoenix. A specific technology has not been selected for this corridor; however both LRT and BRT technologies are capable of serving the projected demand. Utilizing LRT technology would permit better connectivity with the CP/EV, while BRT could provide more cost-effective service with minimal transfer time.

Metrocenter/I-17

Modifications & Refinements

The Metrocenter/I-17 corridor has been extended from its original limits to serve more of the I-17 corridor in the northern MAG region. Previously, this corridor terminated at Dunlap Road and the Metrocenter Mall. Refinements based upon comments from Phoenix have resulted in this corridor being extended to Bell Road in the north. The southern terminus remains at Bethany Home Road and 19th Avenue where the corridor will connect to the CP/EV LRT.

Major Activity Centers

Metrocenter Mall near Dunlap Avenue and I-17

The Metrocenter/I-17 transit corridor has the potential to serve several existing activity centers. These activity centers include the Turf Paradise Race Course, located near the northern terminus, the Westown Shopping Center along Cactus Road, the Metrocenter and Metro Marketplace, located between Peoria and Dunlap Avenue, and the Spectrum (formerly Chris-Town) Mall, located at the proposed southern terminus of Bethany Home Road and 19th Avenue.

Future Population Density and Development Patterns

On average, the Metrocenter/I-17 Corridor has a population density of roughly 8,000 people per mile, in relation to a total population within the corridor of 70,000. Throughout the majority of the corridor, there exists a medium density development pattern, with the highest density occurring at the near the southern terminus.

Connections to Other High Capacity Transit Corridors

The Metrocenter/I-17 corridor provides two important connections to other high capacity transit corridors near its southern end. Near the southern terminus of this corridor are links to the Glendale Avenue corridor and the CP/EV LRT. These links provide connections to downtown Phoenix and Glendale. On the north end of the corridor, a connection to the Bell Road corridor is provided.

Service Parameters

This corridor will be implemented as an LRT corridor consistent with the long range plans for the City of Phoenix. There two possibilities for operating service in the Metrocenter/I-17 corridor. The first possibility is operating as an extension of the CP/EV LRT system with continuous service along the entire corridor, requiring no transfer between alignments. This configuration is most convenient for riders. Headways would be coordinated with the CP/EV LRT. This report proposed for headways of every 10 minutes, while the CP/EV would run every five minutes during peak periods. These operating parameters would allow for a short-turn and long-turn service for these combined corridors. Short-turn service could operate every 10 minutes between Bethany Home/19th Avenue and the East Valley terminus of the CP/EV. An additional 10 minute service could then be provided between Bell Road and the East Valley terminus. The interlining of these two 10 minute frequency routes would provide five minute service between Bethany Home/19th Avenue and the East Valley terminus of the CP/EV LRT. Other alternatives for interlining are possible and will be explored during the future design phases of this project.

A second alternative would be to operate service in the Metrocenter/I-17 corridor as an exclusive corridor with no interlining of service between this corridor and CP/EV LRT. Transfers would be made between the two systems near the 19th Avenue/Bethany Home intersection. While this would impact travel times for riders, it would allow for more flexibility for service on the individual corridor because the service timing would not have to be as precise.

Power Road

Modifications & Refinements

Power Road has not been modified from its original configuration presented in Milestone 4. The corridor still extends from Williams Field Road and Williams Gateway in the south to McDowell and Higley in the north. Modifications could be made in the future to ensure that this corridor serves a future commuter rail station at Williams Gateway; however this level of refinement would occur in a detailed corridor specific study.

Major Activity Centers

Several existing and future activity centers are located adjacent to the proposed Power Road Corridor. Near the northern terminus of McDowell and Higley Road is the Mesa Municipal Airport (Falcon Field). Just north of the Superstition Freeway is the Superstition Springs Center and the Mesa Pavilions. Near the southern terminus of the corridor is the proposed Williams Gateway complex, which, as mentioned previously, will be a large office and research development complex.

Future Population Density and Development Patterns

On average, the Power Road corridor has a relatively moderate population density of approximately 8,550 when compared to a total population of just over 111,000. The population density pattern indicated lower density suburban development throughout most of the corridor.

Connections to Other High Capacity Transit Corridors

Power Road serves the eastern edge of the MAG region and links to several east-west corridors. The southern end of this corridor will be important transfer node with the convergence of the Power Road, Chandler Boulevard, and UP Southeast corridors. Another connection is provided at Main Street, linking the Power corridor to downtown Mesa and Tempe.

Power Road and Ray Road will be a site of future growth in the East Valley

Service Parameters

Power Road is similar to Chandler Boulevard in that it serves a major activity and employment center, but has lower ridership levels than other corridors in the East Valley. This is not to say that the ridership is not substantial. Instead, the ridership figure would likely make this corridor a prime candidate for BRT service, which would likely be more cost-effective given the projected ridership levels. Headways would likely be 15 minutes during the peak period, allowing for on-time links to the Chandler Boulevard corridor. Connections could also be made to the Main Street corridor with minimal wait times that would not exceed five minutes.

Scottsdale Road/UP Tempe Branch

The Scottsdale Road/UP Tempe Branch corridor is combination of the Scottsdale Road/Rural Road and UP Tempe Branch corridors evaluated as part of Milestone 4. This corridor extends approximately 25.5 miles from the intersection of Bell Road and Scottsdale Road in the north to the southern terminus of the UP Tempe Branch near 56th Street and I-10. Both LRT and Dedicated BRT are considered to be viable technologies for this corridor.

Scottsdale Road and Camelback Road will likely be a major transfer point in the high capacity transit network

Modifications & Refinements

This corridor originally extended along Scottsdale Road and Rural Road from Bell Road in the north to Chandler Boulevard in the south, continuing on to terminate at Price Road and Queen Creek Road via Chandler Boulevard and Price Road. Given the proximity of this corridor to the Union Pacific Tempe Branch through the cities of Tempe and Chandler it was determined that these corridors should be combined to avoid direct competition. This combination has resulted in the Scottsdale Road/Rural Road corridor following its original alignment south to approximately Elliott Road and traveling west to the UP Tempe Branch. The corridor would then continue south the UP Tempe Branch terminus near 56th Street/I-10 and Firebird Raceway.

Major Activity Centers

The Scottsdale Road/UP Tempe Branch corridor serves several established and future activity and employment centers. At the far northern end of the corridor is the Scottsdale Airpark. This regional airport is surrounded by a developing commercial office park which will likely become a major employment center in the northern MAG region during the next 20 years.

The next major employment/activity center is this corridor is downtown Scottsdale, roughly occupying the area between Chaparral Road and Thomas Road Avenue. This employment center is home to civic/governmental offices for the City of Scottsdale several major resort hotels, and the Scottsdale Fashion Square, a major regional shopping mall in the eastern MAG region, generating shopping traffic as well as a substantial number of work trips for employees of the mall and its retail stores.

Further south on the corridor south of the Salt River is the Arizona State University (ASU) campus. This major university is currently attended by 40,000 students with future university expansion plans projecting up to 60,000 students. ASU also serves as a major employment center for the City of Tempe and the MAG region with over 7,000 faculty and staff currently employed on campus.

Other major destination points along this corridor include the Gila River Indian Community and the Firebird Raceway near the southern terminus of the corridor.

Future Population Density and Development Patterns

The population density for this corridor averages around 5,700 people per mile, with the highest density occurring near the Arizona State University campus.

Connections to Other High Capacity Transit Corridors

The Scottsdale Road/UP Tempe Branch corridor is a long, linear corridor which extends from the northern and southern ends of dense development in the MAG region. This configuration results in several connection points to other proposed high capacity transit corridors. Connections could be made at Bell Road and Camelback Road in Scottsdale, the CP/EV LRT alignment on Apache Boulevard in Tempe and to Chandler Boulevard near the southern terminus of the corridor. Each of these connection points has the potential of becoming a major transit transfer center providing access to multiple corridors.

Sun Devil Stadium is another major activity center in this corridor

Service Parameters

With the presence of several major activity centers adjacent to this corridor, it is essential that frequent high capacity transit service be provided to serve the projected demand. The overall corridor has significant boardings per mile average when compared to other recommended corridors in the MAG region. A review of ridership using the MAG model will further determine where a majority of the estimated ridership occurs; however, it is possible to assume that a significant portion of potential riders will access the corridor for travel to and from the major central activity centers of downtown Scottsdale and downtown Tempe/ASU. Secondary trip attractors include the Scottsdale Airpark and the industrial park on the Gila River Indian Reservation. The ridership demand in this corridor would likely be suited to LRT service and its higher capacities; however, BRT would likely be capable of providing a similar level of service, particularly in the northern and southern portions of the route where demand is likely not as high as in the central portion. The two technologies could be used in tandem with transfer stations provided at the northern and southern termini for the LRT system. These LRT terminus stations would be located north of downtown Scottsdale and south of ASU.

SR-51

Modifications & Refinements

The SR-51 corridor has been slightly revised in the southern portion to connect to the CP/EV LRT at Central Avenue and Indian School Road. Future studies for service in this corridor will need to determine the best way to coordinate service in this corridor and the Camelback corridor between Central Avenue and SR-51. If the same technology is selected for both corridors, a short portion of interlining would occur within this section. If different technologies (LRT or Dedicated BRT) are selected for the two corridors, separate alignments would need to be selected between Central and SR-51. The most cost-effective solution would seem to be to coordinate the technology between these corridors. However, other issues in other portions of these corridors may lead to differences in the recommended technologies.

Major Activity Centers

The activity centers passed by the proposed SR-51 corridor include the Paradise Valley Community College on Union Hills Drive, near the northern terminus of the corridor and the Plaza De Campana and Paradise Valley Hospital, both located along Bell Road.

Future Population Density and Development Patterns

The average population density along the SR-51 Corridor is approximately 7,100 with a total population of just under 124,000. In comparison to other corridors, this is relatively moderate. The highest centers of density occur near Bell Road towards the northern terminus and at the southern terminus, just north of downtown Phoenix.

The Paradise Valley Mall area is a major ridership generator in the SR-51 corridor

Connections to Other High Capacity Transit Corridors

The SR-51 makes an important connection to the CP/EV LRT alignment at Central Avenue, connecting the Paradise Valley/Dreamy Draw areas with downtown Phoenix. Other connections are proposed at Camelback Road and Bell Road, linking this corridor to downtown Scottsdale and the Scottsdale Airpark.

Service Parameters

Service in the SR-51 corridor is proposed to operate at 10-minute headways in the peak period. If LRT is selected as the preferred technology for this corridor, it is highly likely that this alignment would be interlined with the CP/EV on Central Avenue between Indian School Road and central downtown Phoenix. This short distance would cut travel times by reducing a possible transfer between LRT systems and could boost ridership. As discussed above, the potential for interlining with the Camelback Road corridor would be determined as alignments and technologies are finalized.

Union Pacific Chandler Branch

Modifications & Refinements

The UP Chandler Branch corridor runs from Main Street in the north to Price Road and Queen Creek Road in the south. The corridor previously only ran to the Union Pacific Southeast corridor near Baseline Road. This extension allows for connections to the Main Street corridor and the proposed Mesa commuter rail station on the UP Southeast.

The Chandler Civic Center is an activity center in the UP Chandler Branch corridor

Major Activity Centers

Major activity centers for this corridor include downtown Mesa and surrounding museums, such as the Southwest

Museum, and the Chandler Civic Center.

Future Population Density and Development Patterns

On average, the Union Pacific Chandler Branch Corridor has a population density of approximately 9,400 people per mile. The population density pattern is generally consistent throughout much of the corridor, with the most dense development pattern occurring along the northern segment of the corridor.

Connections to Other High Capacity Transit Corridors

As mentioned above, the UP Chandler Branch corridor will connect to the Main Street corridor and the UP Southeast corridor at its northern end. Near the southern end of this corridor is a connection to Chandler Boulevard. The connections located at the northern terminus of this corridor will likely be the major focal points for transfer activity between systems since the Main Street and UP Southeast corridors provide links to major activity centers such as Tempe/ASU and downtown Phoenix.

Service Parameters

Headways of 10 minutes in the peak period are proposed for this corridor to serve the estimated ridership. This corridor performs well in relation to other corridors in the East Valley and would likely serve as a major north-south travel corridor between Mesa and Chandler and Gilbert. The service should be coordinated well with transit service on Main Street to allow for timely transfer between the systems. Adequate connections to the UP Southeast commuter rail line should also be provided. This corridor will serve as the link to commuter rail service for commuters in Chandler. Both LRT and BRT could be viable technologies for this corridor given ridership projections. However, the final alignment and coordination with Union Pacific for use of portions of the Chandler Branch will play a large role in the technology selection. While LRT may seem to be more compatible with freight rail, there have been successful implementations of BRT service parallel to active freight lines in Pittsburgh.

UP Southeast

Modifications & Refinements

No modifications have been made to the UP Southeast corridor. Commuter rail service in this corridor is still proposed to run from downtown Phoenix, through Tempe and Mesa to Queen Creek along the UP Mainline. Station locations remain the same for this report: Sky Harbor Airport, downtown Tempe, East Tempe, downtown Mesa, Gilbert, Williams Gateway, and Queen Creek.

Major Activity Centers

As with the other two commuter rail corridor alternatives, the Union Pacific Southeast corridor would serve the activity centers of downtown Phoenix. To the east of the Civic Center, the corridor serves the Arizona State Hospital, just to the north along 24th Street. Directly to the south and adjacent to the corridor is Sky Harbor International Airport. Further east along the corridor is the Arizona State University main campus, which is a major employment and activity center for the region.

The corridor also serves downtown Mesa, the Gilbert Towne Centre and is a short distance from the proposed Williams Gateway development.

Future Population Density and Development Patterns

On average, the Union Pacific Southeast corridor has a low population density of approximately 6,800 when compared to a total population of over 245,000. The population density pattern however is sporadic, and higher density locations do exist along portions of the corridor. These areas are located near downtown Phoenix and Arizona State University Campus. In general, the development pattern becomes less dense as the corridor gets further from the Phoenix Civic Center.

A proposed station near Williams Field Road will be a major access point to Williams Gateway

Connections to Other High Capacity Transit Corridors

The UP Southeast corridor makes two major connections to proposed LRT/Dedicated BRT corridors at Main Street and UP Chandler Branch in Mesa and with Chandler Boulevard and Power Road near Williams Gateway. These connections with allow for interfacing between the various transit technologies and provide a larger portion of the East Valley with access to commuter rail service. The UP Southeast corridor also links with the BNSF and UP Yuma corridors in downtown Phoenix.

Downtown Tempe will be a major destination point for commuter rail service in the UP Southeast corridor

Service Parameters

Commuter rail service on the UP Southeast corridor would be implemented in phases, starting with a limited peak period service inbound to downtown Tempe and downtown Phoenix. Future phases will add reverse commute service to Williams Gateway and additional service during peak and off-peak times. Peak period headways will again be 15 minutes in the inbound direction and 30 minutes in the outbound.

UP Yuma

Modifications & Refinements

The UP Yuma corridor remains the same for this Milestone 5 report. An extension to Palo Verde Nuclear Generating Station was analyzed and discussed in Section 5.1 and was determined to not be a cost-effective alternative to the base UP Yuma corridor extending from Buckeye to downtown Phoenix. Stations are located in Buckeye, Goodyear/Avondale, Tolleson, and West Phoenix.

Buckeye is an area of major future growth along the UP Yuma corridor

Major Activity Centers

The Union Pacific Yuma rail corridor serves two existing major activity centers. Adjacent to the eastern terminus of the corridor is downtown Phoenix. Similar employment centers exist along the corridor in Goodyear, Tolleson and West Phoenix.

Future Population Density and Development Patterns

Like the BNSF Commuter Corridor, the Union Pacific Yuma corridor has a low population density pattern, with approximately 4,000 people per mile, when compared to a total population within the corridor of just over 123,000. Again, the development patterns become less dense the farther the corridor gets from downtown Phoenix.

Connections to Other High Capacity Transit Corridors

The UP Yuma corridor could provide a connection to the 59th Avenue corridor. The existing maps in Milestone 5 do not show this connection; however future alignment studies for both corridors should develop a way to link a commuter rail station in West Phoenix to the LRT/Dedicated BRT service proposed for the 59th Avenue corridor. Additional links are available in downtown Phoenix to the UP Southeast and BNSF corridors, as well as the CP/EV LRT.

Service Parameters

As with the BNSF corridor, commuter rail service on the UP Yuma corridor would be implemented in a progressive fashion beginning with a limited start-up phase operating during peak periods and building up to a full service configuration with 15 minute peak service, reverse commute and frequent off-peak service. Outbound peak period service would be provided with 30 minute headways.

5.2.3 Network Coverage

The overall objective of the Recommended High Capacity Transit Network is the creation of an integrated system of high capacity transit corridors providing efficient and convenient travel throughout the MAG region. An important part of these corridors fulfilling their objective is to insure that there are connections between the corridors and that these connections facilitate the movement of riders between systems no matter which transit technology is being operated.

Exhibit 5.2-2 illustrates the Recommended High Capacity Transit Network as an integrated network of corridors. The likely connection points between each corridor and intersecting corridors are illustrated in this map along with the connections made to the assumed base high capacity transit corridors such as the CP/EV LRT.

RECOMMENDED HIGH CAPACITY TRANSIT NETWORK
Legend
Station
Connection
Commuter Rail
CP/EV LRT
Existing Express BRT
LRT/Dedicated BRT
Proposed Express BRT
Freeway
Proposed Freeway/Parkway/Highway
Major Arterials
0 1.25 2.5 5 7.5 10 Miles
DRAFT: December 31, 2002
Surprise
ElMirage
Peoria
Bell Road
Glendale Avenue
59th Avenue
W. Phoenix Glendale
Metro Center
SR-51
Camelback Road
Scottsdale Road
I-10 West
Tolleson
West Phoenix
Downtown Phoenix
Sky Harbor
Downtown Tempe
East Tempe
Main Street
Mesa
Central Avenue South
Goodyear
Buckeye
Up Tempe Branch
Up Chandler Branch
Gilbert
Power Road
Chandler Boulevard
Williams Gateway
Queen Creek

5.2.4 Feeder System Role

Although the majority of feeder networks are expected to be provided by the existing transit network, there may be a need for a feeder bus network to link with high capacity transit services. Key considerations when determining whether feeder bus services are warranted include:

- Proximity to employment sites and limited or no existing transit service
- Capacity constraints as defined by parking availability and affordability
- Direct transit service connections to nearby activity centers
- Community support
- Private sector funding

These criteria were discussed in detail in Milestone 4. Although it is not possible to identify exactly which stations warrant feeder bus service at this time, it is valuable to note that where stations are more than one-half mile from a major activity center, then feeder bus service may be needed. Since the proposed high capacity transit service is a long-term plan, significant growth in several cities is expected to occur in the next 20 years. For example, in Scottsdale a major new shopping development is planned and in Glendale, a major sports complex will come on line in this timeframe. Depending on the exact citing of the stations, a feeder bus service may be an attractive element of the high capacity transit service, and funded, in part, by the new developments.

The following section reviews some of the benefits and challenges of a feeder bus service and factors to consider for the 12 LRT/Dedicated BRT corridors and the three commuter rail corridors.

Feeder bus service can offer a high quality and convenient connection from rail stations to nearby destinations, such as an employment or commercial sites or other major activity centers. Where feeder bus service is warranted, it is viewed as an integral extension of the rail service and without it, service may not be very attractive. A well designed and operated feeder bus service enhances the overall attractiveness of the rail service.

This is not to suggest that there are no challenges for feeder bus services. The three biggest challenges are schedule coordination, fare integration and joint marketing efforts with the high capacity transit rail service. Coordinating schedules with bus and rail services, especially if operated by two different agencies, can be difficult to achieve. It is, however, imperative that feeder bus services are timed to regularly meet the trains. For feeder bus service designed to meet trains at the *destination* station, buses should be waiting so passengers can immediately board without delay. For service provided at the station of origin, buses should arrive approximately ten minutes ahead of the next train departure. As train schedules periodically adjust, so too must feeder bus schedules.

The fares proposed for high capacity transit service cover rail fares *only*. This means that passengers may need to pay a separate fare on feeder bus connections. If service is cooperatively funded with private contributions, then it is possible for a "free" service or fares could be kept low. While separate fares can be viewed negatively, if the feeder bus fare is kept to a minimum, then it may not be a significant deterrent.

Another challenge is to develop a joint marketing and public information campaign that encompasses both rail and feeder bus services. If feeder services are considered essential at select stations, then accurate and easily understood information about both services need to be made available to the public. Since feeder bus services tend to be operated by the private sector and rail service is typically operated in the public arena, it can be a challenge to cooperatively prepare and distribute the information. This is an important aspect to make a service successful, particularly a new service in an area unaccustomed to rail service.

There are some special considerations with respect to feeder bus service for the proposed light rail corridors and the commuter rail corridors.

Light Rail

The proposed frequency for the light rail corridors during peak periods range between 10 and 15 minutes. This means that feeder bus service needs to be provided frequently to meet every train. The more frequent the service, the more costly the service. Light rail station stops along a light rail corridor line tend to be spaced closer together than commuter rail, which may also mean more bus feeder routes.

Because light rail has more closely spaced stops and is implemented along higher density demand corridors than commuter rail, dedicated feeder services will be less important because most of the activity along these corridors will be served by the existing bus transit network. Major employment centers, retail centers, office parks and hospitals without direct and well-timed bus access to a light rail station will require feeder services to allow their employees, customers or clients to use the HCT network. Typically provided by private operators, the availability of these services is unlikely to have as significant an impact on LRT ridership as it would on commuter rail services.

Commuter Rail

Commuter rail station stops tend to be further spaced than Light Rail stations and they operate less frequently. This means that feeder bus services are even more important at commuter rail stations and must achieve excellent schedule coordination for the service to be successful.

Feeder buses will be important at those commuter rail stations with the greatest ridership volumes – typically those with over 1,000 daily boardings – because these will be the most significant activity centers along the commuter rail lines. These stations will be served by major bus lines and may offer amenities and services not available at other high capacity transit facilities. These are likely to become intermodal centers allowing pedestrians, bicycle users, drivers, and bus riders to connect to rail lines. Major employment centers, such as office parks and hospitals, not directly link to the station via a bus line will demand a feeder link to the commuter rail system. For example, along the BNSF rail line, overall boardings are strong at several stations including those in out portions of the metropolitan area. Dedicated feeder services may further increase boardings and alightings at these stations because major employers would become involved in providing feeder connections between worksites and the commuter rail station. These feeders are primarily going to be distributors because their focus is on the activity or employment centers. Not the residential trip ends.

5.2.5 High Capacity Transit and the Developing Valley Metro Network

High capacity transit services will effectively replace some local bus services, but much of Valley Metro's growing grid system will remain intact. Even with high capacity transit services in operation, fixed route and shuttle bus services will continue to provide important local circulation in many of Maricopa County's communities, as well as some regional BRT Express services on freeways, utilizing park-and-ride lots and HOV lanes.

A separate ongoing project, the Valley Metro Regional Transit System Study, is identifying the local and express bus network for Maricopa County for 2025. That study is modeling transit demand based on changes in population growth, land use and densities over the next 25 years. The focus of the study it to identify the need for bus transit services based on density and transit dependence. The transit-dependent market — a significant component of the analysis as part of the Regional Transit System Study — is one of many markets that would be served by a high capacity transit system. The methodology for assigning services as part of the Regional Transit System Study was similar to the effort undertaken for the High Capacity Transit Study, but with one key difference: the High Capacity Transit Study has a limited number of corridors where services can be implemented, and corridors cannot be defined as narrowly as they are in the Regional Transit System Study.

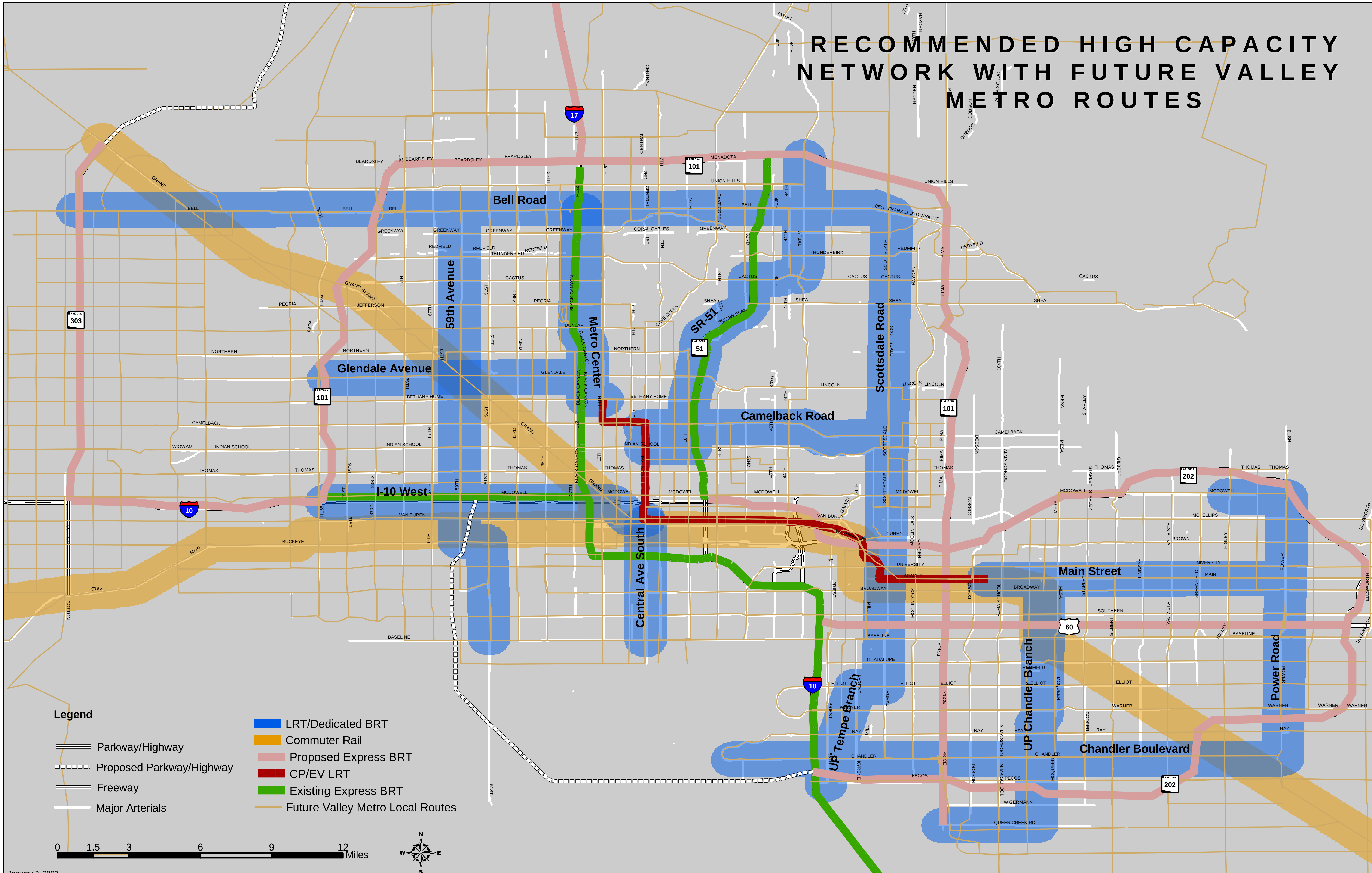
The team for the Regional Transit System Study used a future street network and projected population and employment data to create a grid of potential future transit routes serving all of Maricopa County. These bus routes were assigned levels of transit service based on the demographic and employment characteristics of areas served. Routes serving high density areas and areas with highly transit-dependent populations were assigned the highest frequencies of service and longer hours of operation.

Exhibit 5.2-3 illustrates that most of the high capacity transit corridors parallel arterials that have been targeted for local bus service in the Regional Transit System Study. The figure shows that by 2025, high levels of local bus service are projected along all major arterials in the metropolitan area. Also on the map are proposed high capacity transit services. Because the high capacity transit services are nearly five miles in width, there is considerable integration of the various service types because up to five parallel local services may operate within the high capacity transit corridor.

In addition, where bus lines and high capacity transit lines intersect with each other, the network provides numerous opportunities for transfers between the different modes. For example, proposed station locations along the Metrocenter/I-17 BRT/LRT corridor would be at all major intersecting arterials (for example, Thunderbird, Cactus, Peoria).

The high capacity transit network consists of commuter rail and light rail/BRT corridors. Corridors identified for commuter rail service tend to have longer distances and will have limited stops and at start-up, limited service hours. The four commuter rail corridors included among the alternatives for the High Capacity Transit Study parallel one or more of the local lines that were preliminarily drafted as part of the 2025 Valley Metro transit network. The exception is the UP Southeast Line that runs at an angle to the grid network assumed by the Regional Transit System Study planners.

All of the alternatives for LRT/BRT operate in the higher density corridors that have been targeted by Regional Transit System Study planners for fixed route and commuter connection bus service. For example, the Camelback Road Corridor has been identified by High Capacity Transit planners as an important corridor for BRT/LRT, particularly since Camelback Road congestion is projected to increase by 30 percent between now and 2040. Employment density along this corridor is among the highest in the region, and population density is also strong. This mix of high employment and population density contributes to making this an attractive corridor for high capacity services, but the mix of land uses also suggests a high number of local trips may be better served by the fixed route bus system.



RECOMMENDED HIGH CAPACITY NETWORK WITH FUTURE VALLEY METRO ROUTES
Bell Road
Glendale Avenue
59th Avenue
Metro Center
SR-51
Camelback Road
Scottsdale Road
I-10 West
Central Ave South
Main Street
UP Tempe Branch
UP Chandler Branch
Chandler Boulevard
Power Road
Legend
Parkway/Highway
Proposed Parkway/Highway
Freeway
Major Arterials
LRT/Dedicated BRT
Commuter Rail
Proposed Express BRT
CP/EV LRT
Existing Express BRT
Future Valley Metro Local Routes
0 1.5 3 6 9 12 Miles
N
S
W
E
January 3, 2003
Network with Valley Metro

5.3 Implementation Plan

An important component in developing a recommended high capacity transit network is determining when and how the corridors should be implemented. Proper phasing of projects is essential to ensure that growing ridership demands are met and that improvements are scaled to funding levels available. This section will provide a brief overview of phased implementation of transit services, why it is done, a preliminary phasing plan for each recommended high capacity transit corridor, a recommended prioritization of the corridors, a discussion about technology selection, and an action plan detailing the next steps in moving closer to corridor implementation.

5.3.1 Phasing Overview

The levels of service described for each of the commuter rail, LRT, and Dedicated BRT corridors in this report represent the *ultimate level of service* that each transit technology must provide to accommodate the ultimate estimated ridership demand in the various corridors. This ultimate level of service would be achieved at full development of the system. In reality, the development of service would be implemented in phases over a period of years, as underlying population and employment growth drives new ridership. Several criteria are involved in determining the phasing-in of new high capacity transit service. These criteria are essentially similar from technology to technology; however, there are distinctive differences. A general overview of why phasing is a preferred option for implementing high capacity transit along with a description of phasing steps for each technology are presented below.

Commuter Rail

As described in the ridership and cost estimates, this report has explored three major phasing steps for implementing commuter rail service. Each phase represents a dramatic improvement in service above the previous level of service. There are several ways of transitioning between levels of service. This transition can be done incrementally with only a single roundtrip train added each year, or improvements can be implemented through a larger change from one phase to the next. The driving factors behind the pace of implementing later phases of commuter rail will be funding availability and ridership growth. The three major phases of commuter rail implementation are described below.

<u>Start-up Phase</u>

Virtually all of the recent West Coast commuter rail start-up operations began as modest systems providing service during peak commute periods inbound to a downtown or central business district in the a.m. peak and outbound to the suburban areas in the p.m. peak. In many cases, service is provided by two or three trains during each peak period. Minimal or no off-peak service is provided during the initial phase. Capital costs are part of the reason for a limited implementation in the first phase of service. Infrastructure improvements and vehicle acquisition can be expensive and having a small initial capital outlay places the transit agency in a less risky position and could increase opportunities for acquiring Federal funding. This phase is designed to be the first step in introducing commuter rail to commuters, with the objective of building a ridership base which can be expanded upon in future phases. Reliable service is very important during this phase, as a much higher percentage of new commuter rail riders were previously automobile users than is the case with other transit technologies. These new riders would also be more inclined to give up on transit service if it is slow, unreliable, or qualitatively inferior to the auto alternative.

<u>Intermediate Phase</u>

The Intermediate Phase of commuter rail can take many forms and it is difficult to define in terms of a set number of train trips per day and per peak period. In Milestone 4, this service was defined as providing service with six peak period trains and hourly service during off-peak hours. Span of service is usually extended to midday and early evening, for a total up to approximately 12 to 15 hours. Many times, a reverse commute service is implemented, but at lower frequencies than in the primary travel direction. While a specific number of trains in service has not been defined here, specific characteristics of the intermediate level of service are identified as:

- Increased peak period service (20-30 min headways)
- Reverse commute service
- Midday and evening trains
- Increased span of service
- Additional round trips per day above initial service (6 to 12 trains per day)

<u>Ultimate Phase</u>

This service is defined as providing the maximum amount of commuter rail service that a corridor is capable of supporting given ridership demand and infrastructure capacity. This form of service is on display in several East Coast cities such as New York, Boston, Philadelphia, and Chicago. Train service during peak times is very frequent (15 minutes or less) and a substantial amount of off-peak service is provided. At this level of service commuter rail is capable of moving a large number of people per hour over relatively long distances.

The specification assumptions also include a provision for seating almost all riders. While this may seem to be an obvious provision, many traditional commuter rail operations assume that many peak services will require substantial portions of those on board to stand for part, or even the entire journey (commuter vehicle capacities typically have a 1:2 or more ratio of seated to standing riders). While this may be acceptable in mature markets in the Eastern U.S., newer Western systems have generally higher levels of per-passenger space provision and lower density seating arrangements. It is unlikely that a commuter rail service that expects customers to stand daily on a 30+mile journey from, say Surprise to Tempe, will be qualitatively competitive with the auto, regardless of any potential time savings. This “aim to seat all” assumption adds rolling stock and capital costs to those which might typically be encountered, even from the Start-up Phase. The exception to this level of provision would be on those occasions where additional demands arise over and above base daily ridership, such as special events, or on very short 1-2 station journey segments where sizing the train consists to the absolute peak demand would not make economic or operational sense

Light Rail

Light rail is a very different technology from commuter rail in terms of its operating characteristics. LRT systems are designed to provide frequent, all-day service from the first day of implementation, unlike commuter rail which can be a viable service with only two to three trains operating each day. A primary reason for this initial implementation of frequent service is the large amount of capital investment required to implement LRT. Commuter rail in many cases can utilize existing rights-of-way and infrastructure, while LRT requires new right-of-way and entirely new infrastructure in order to begin operations. This sizable initial investment requires a higher rate of return on the investment soon after the opening of service. The commuter rail assumption of “aim to seat all” would also not be a practical proposition for LRT, due to the much shorter average journey length, frequent stops and short dwell times for boarding/alighting.

Phasing in of LRT service would primarily consist of gradual shortening of headways and increased spans of service. Many LRT systems will open with 10 to 15 minute headways during peak periods and 20 to 25 minutes in off-peak times. As ridership levels grow headways would be shortened to five minutes or less during peak times and 10 minutes or less during off-peak. Several established LRT systems such as the Santa Clara Valley Transportation Authority’s LRT in San Jose also now provide service 24 hours a day.

Bus Rapid Transit

BRT technology is similar to commuter rail in that the phasing of service is very flexible, and can be implemented of a series of small stages over time to allow for funding availability and ridership growth. The lower infrastructure requirements for BRT allow for minimal levels of investment to begin a basic service and the flexibility of BRT vehicles allows for a staged implementation over many years.

The first phase of BRT service is typically the implementation of a "rapid" or limited stop bus service. An excellent example of this service is present in Los Angeles where the Los Angeles County Metropolitan Transportation Authority (MTA) has implemented two new Rapid Bus lines on Wilshire Boulevard and Ventura Boulevard. The only capital investment required for implementing service was the purchase of new 40 foot natural gas buses, new station/stop displays, and the installation of signal priority control systems at intersections in each corridor. Stations were located approximately one mile apart to increase operating speeds, rather than every ¼ or ½ mile like on a typical bus route. The buses on these routes operate in mixed-flow vehicle traffic. Service in both routes has been very successful when compared to transit ridership in each corridor prior to Rapid Bus implementation. An expansion of the Rapid Bus concept is planned for approximately 20 other street corridors in Los Angeles County. Future phasing plans call for the implementation of exclusive bus lanes in each corridor. Because of the flexibility of this phase of BRT service and the overall limited capital investment required, rapid bus could also be used as an initial phase building up the implementation of an LRT system. Once the LRT service is in place the buses used to operate rapid bus service could be reassigned to other corridors.

Bus lanes represent the next phase in implementing BRT service. These lanes are usually located on the curb side of an arterial street and can either be exclusive or allow for some vehicle traffic during off-peak times or at intersections for turning movements. Depending upon available right-of-way in the street corridor, the implementation of bus lanes may require limited acquisition of property; possibly justifying the initial use of rapid bus service until full funding is available and a strong market has been established.

Exclusive bus lanes separated from vehicle traffic either in the street median or an exclusive right-of-way such as a former freight railroad corridor represents the ultimate phase of BRT service. This service requires the greatest level of capital investment, but is capable of providing faster service than other forms of BRT as a result of the exclusivity of operations from cross traffic interference. Headways during this phase of service could be as short as two minutes during peak periods. BRT has a larger capacity to move thousands of riders per hour with exclusive operating lanes. For example, the Ottawa Transitway allows for the movement of up to 10,000 people per hour per direction during peak periods. The MTA Ventura corridor's next phase of development, beginning construction in 2003, is just such a transition from street-running Rapid Bus to a largely segregated busway.

Phasing

Overall phasing of service may result in the total long term capital cost of implementing transit service to be higher than if the service was implemented at full capacity immediately. However, the latter approach is not usually realistic given the cost investment required to implement a full service transit system. Similar to the development of a freeway network when a six lane freeway is widened to eight lanes to meet growing demand, improvements are done to transit systems in phases to match growing ridership demand. This spreads the cost burden over several years or possibly decades allowing for benefits to be provided at an earlier stage than if construction was delayed until the full system could be implemented.

5.3.2 Phasing Recommendations

As mentioned above, the ultimate level of high capacity transit service is not usually implemented in a single step. Instead, service is introduced in a series of phases, each phase offering more frequent and expended service than previously available. Just as each of the three transit technologies has unique capabilities for phased implementation, each of the 15 high capacity transit corridors in the recommended network has unique characteristics that will drive how transit service will be implemented over time. A preliminary recommendation for phasing high capacity transit service in the 15 recommended corridors follows. These are not final recommendations, but instead should serve as guides for the detailed Major Investment Studies (MIS) that will be required for each corridor.

59th Avenue

This is a long (19 miles) corridor that traverses areas of established residential and commercial development in the northern sections and areas slated for future growth in the southern portions. The corridor includes a mix of residential, commercial, and industrial development. Given existing and future growth patterns, transit service is most likely to be needed initially in the northern (Bell Road to Glendale Avenue) and central (Glendale Avenue to UP Yuma) portions of this corridor. These sections of the corridor have a high level of existing development and a major activity center in the form of downtown Glendale. The southern end of this portion also includes a heavy industrial employment base. Based on these conditions, it is recommended that high capacity transit service be implemented initially between Bell Road and the UP Yuma rail line. Initial service would likely consist of rapid bus with stations located every mile on the arterial street grid network. As ridership grows more advanced high capacity transit could replace the rapid bus service. Projected ridership levels in this corridor suggest that Dedicated BRT would be best suited to providing cost effective service; however detailed future analysis will determine the appropriate technology. In the long term (20 to 40 years) high capacity transit service would be expanded to the full length of the corridor and bring new service to southern section between UP Yuma and Baseline Road, linking the southwestern Phoenix communities to downtown Phoenix via the UP Yuma and I-10 West corridors.

Bell Road

Bell Road is another long, linear corridor that will likely see high capacity transit implemented in sections rather than all in one piece. The most likely areas for initial service will be the portions between 59th Avenue and I-17 and between SR-51 and Scottsdale Road. Both of these sections serve high levels of existing development and expanding activity centers in the form of Scottsdale Airpark and the Deer Valley area. These segments also link to several other high capacity transit corridors serving north-south travel demand. These types of linkages are essential in creating an integrated high capacity transit network. Later phases of implementation would expand service between I-17 and SR-51 and east of 59th Avenue to Loop 303.

As is the case with 59th Avenue, the first phase of high capacity transit service in the Bell Road corridor would likely be rapid bus with stops every mile. This service could initially be provided in the entire 28 mile corridor if demand warrants because of the lower initial implementation cost. Enhanced services would then be introduced in the two sections noted above between 59th Avenue and I-17 and SR-51 and Scottsdale Road. The length of this corridor probably would be best suited to a BRT service given the estimated cost of a 28-mile LRT line ($1.1 billion) in the corridor. The overall capacity of a Dedicated BRT service also fits well with ridership demand in the corridor.

BNSF

Phasing for commuter rail service has been described in detail earlier in this report, so the description of phasing for the BNSF corridor will focus specifically on the corridor length, stations, and timing of the implementation of each Phase. Between Surprise and downtown Phoenix the BNSF corridor is approximately 26 miles in length. This length is shorter than many of the West Coast commuter services operating today. This short distance would allow for full implementation of the route initially if ridership demand warrants this service. An analysis of the timing of future growth in Surprise and other outlying communities in the corridor suggests that the commuter rail service to Loop 303 may not be required initially. Should service be implemented during the next 10 to 15 years, a likely scenario, the demand for ridership would likely only require service be provided to El Mirage or Bell Road. Extension of the service to Loop 303 would then occur later once population growth in Surprise meets projected levels. Midline stations in Peoria, Glendale, and West Phoenix appear to be justified for implementation with the initial service. No other midline stations are recommended because of the negative impact this would have on train operating speed and the capability of these stations to meet expected demand.

Phase 1 service could be feasible for implementation during the next 10 to 20 years depending upon funding availability, negotiations with BNSF and the relocation of the BNSF freight yard facility. Expansion of service to Phase 3 would be a gradual process relying upon funding available for adding a second main track and ridership growth. Based on current forecasts, it is probable that full Phase 3 service would not be required for a minimum of 30 years and more likely 40 years into the future.

Camelback Road

The Camelback Road corridor between Central Avenue and Scottsdale Road is a dense, congested corridor that will likely warrant early implementation of some form of high capacity transit. This same density, however, may limit the type of service capable of being implemented without having negative effects upon adjacent land uses. The ridership levels estimated for this corridor suggest that it would be capable of supporting an LRT service, but the corridor conditions would require this service be placed on a separate parallel alignment. Rapid Bus service could be specifically implemented on Camelback Road in the near term, existing ridership levels suggest that this service could be justified operating today and certainly once the CP/EV LRT is opened. Long term implementation of more robust high capacity transit service will be dependent upon identification of parallel alignments and sufficient funding for right-of-way acquisition. LRT service would likely be recommended to possibly integrate with the Glendale Avenue corridor to create a central, east-west corridor across the MAG region.

Central Avenue South

This portion of Central Avenue between Jefferson and Washington Streets and Baseline Road is already slated for implementation as a Dedicated BRT corridor. Given the results of the evaluation conducted on this corridor in this report, the proposed Dedicated BRT service should act as a first phase in the development of high capacity transit on Central Avenue South. Ridership demand in this corridor suggests that an LRT service could be supported within the first half on the 40-year planning horizon of this study.

The initial phases of BRT service could consist of a Rapid Bus operation designed to link to one or more of the proposed CP/EV LRT stations in downtown Phoenix. As demand increases, a Dedicated BRT service in an exclusive guideway or in a designated traffic lane would likely be required. Transit demand is already strong in this corridor and the opening of the CP/EV LRT will serve to increase demand further. The Rapid or Dedicated BRT service should be prepared to be implemented in conjunction with the CP/EV LRT or soon after the beginning of service.

Another important issue with the phasing of service on Central Avenue is the type of links provided between LRT service on Central Avenue South and the CP/EV, I-10 West, and SR-51 corridors. Interlining routes would likely have a positive impact on ridership; however, this step may need to be taken incrementally depending upon the timeframe of service implementation for each of these corridors.

Chandler Boulevard

The Chandler Boulevard corridor is seen as more of longer term corridor than some of the others identified above. The major ridership generators in this corridor will likely be the Williams Gateway in the east and Chandler High Tech corridor in the west. Existing transit services in this corridor are minimal and the first step in implementing high capacity transit service will be to improve local bus service to serve the entire corridor. This level of local bus is not warranted at this point given the limited development east of Arizona Avenue. Within the next decade, this local bus service will likely be more viable and should continue to grow as Williams Gateway develops.

The first phases of high capacity transit service in this corridor will likely consist of express BRT services to the Chandler High Tech corridor and Williams Gateway. These services could be true Express BRT, running non-stop from park-and-rides directly to the employment centers or they could take the form of limited stop buses with stops located very one to two miles. As ridership and development in the corridor increase, a more robust BRT service would be incrementally introduced. A prime area for this service is the portion of the corridor between Loop 101 and Williams Gateway, given the connections provided to Loop 101 and the UP Chandler Branch corridor.

Glendale Avenue

The Glendale Avenue corridor is designed feed into the CP/EV LRT corridor and could be linked in the future to the Camelback corridor to create an east-west LRT system linking the central portion of the MAG region. The preferred technology for this corridor will likely be LRT as a result of a ballot measure and the connections to the CP/EV LRT. The initial phase of the service in this corridor will likely extend from Grand Avenue to 19th Avenue based upon existing and near-term development. The major focus of development west of Grand Avenue will be the Glendale Sports and Entertainment Complex at Loop 101. As this complex develops over the next decade, LRT service would then be extended to serve this area. In the short-term, a rapid bus service could link downtown Glendale with the Sports Complex until funding for this portion of the LRT corridor is identified.

I-10 West

This corridor is another recommended for near term implementation to link with the CP/EV LRT. The I-10 corridor between Loop 101 and downtown Phoenix is already heavily congested and high capacity transit service would have a high likelihood of success. Initial service would be provided in the form of Express BRT services and possibly limited stop bus service on parallel arterials. These BRT services would be designed to accommodate existing demand while the LRT system is being designed and constructed. The initial portion of the LRT alignment would likely extend from the CP/EV LRT west to the Desert Sky Mall, a developing transit center in the West Valley. This portion of the corridor exhibits the highest level of demand would be most capable of supporting the initial phases of LRT service. As growth west of the Desert Sky Mall continues, the LRT service could be extended to Loop 101. Long term (30+ years) the LRT could either travel north up Loop 101 to connect with the Glendale corridor or extend further west to Goodyear.

The I-10 West has a unique situation with the provision of a 50-foot wide transit reserve in the median of the freeway. This reserve exists due to a requirement established for the receipt of Federal funding to improve the freeway. Over the years, this transit reserve has been somewhat compromised by the implementation of direct HOV ramps in downtown Phoenix, but for the most part this corridor remains intact. An MIS for this corridor would require future discussions with the Arizona Department of Transportation (ADOT) to determine how the transit reserve can be best utilized.

This corridor will also require some additional service beyond the western limit of the corridor. Future growth in Buckeye and the Loop 303 corridor could create demand for Express BRT services that would feed into the LRT system from several points in the West Valley.

Main Street

Main Street in Mesa is another near-term corridor with a case for implementation soon after the opening of the CP/EV LRT. Initial service in this corridor would take the form of rapid bus service along Main Street between Power Road and the CP/EV terminus to provide a link between the CP/EV and downtown Mesa and the dense residential developments further east. This rapid bus service would act as an extension of the LRT service, extending faster, high-quality transit service at a lower overall cost. Long-term service in this corridor would require a more developed high capacity transit service in form of exclusive Dedicated BRT or LRT. A specific technology would be determined as part of a MIS. An important consideration in the selection of a technology for this corridor and the phasing in of this technology will be the interaction between the Main Street corridor, the CP/EV LRT, the UP Chandler Branch corridor, and the UP Southeast commuter rail. Transfers between the corridors will need to be efficient and convenient in order to realize the overall transit ridership potential in this area of the MAG region.

Metrocenter/I-17

The Metrocenter/I-17 corridor exists in a highly congested area in both the existing and future conditions. This corridor is another extension of the base provided by the CP/EV LRT. The first phase of high capacity transit service in the corridor will likely be Express or rapid BRT service feeding the CP/EV LRT terminus at 19th Avenue and Bethany Home. The implementation of LRT service between Bethany Home and Metrocenter Mall would be the second phase of service. This first extension of LRT service is a prime candidate for near-term implementation during the next decade. The northern portion of the corridor between Metrocenter and Bell Road would continue to operate Express or Rapid BRT services until ridership demand and funding availability allow for the further extension of LRT service beyond Metrocenter. As is the case with the I-10 West corridor, extensive development along I-17 north of Bell Road will likely require extensive Express BRT services designed to feed into the LRT corridor, extending the reach of high capacity transit to lower density areas in a more cost effective manner.

Power Road

The Power Road corridor is similar to Chandler Boulevard in that the full implementation of high capacity transit services would a long-term process that would culminate near the end of the 40-year planning horizon in the this study. The first phase of enhanced transit service in the corridor should take the form of Express or rapid BRT service between Main Street and downtown Mesa and Williams Gateway. Linking these two activity and employment centers will be essential to meeting the travel demand projected in the Power Road corridor. The development of Williams Gateway will drive the enhancement of transit service in the Power Road corridor. The estimated ridership in this corridor could be accommodated with a Dedicated BRT service and would most likely be suited to this transit technology.

Scottsdale Road/UP Tempe Branch

At 25 miles, the Scottsdale Road/UP Tempe Branch corridor is the second longest LRT/Dedicated BRT corridor included in the Recommended High Capacity Transit Network. This corridor can be divided into three segments for the implementation of high capacity transit service. The central portion of the corridor between downtown Scottsdale and the CP/EV will require near-term implementation of high capacity transit service. Ridership estimates for this portion of the corridor suggest that an LRT system would be most appropriate to meet projected demand. Initial phases of this service could take the form of rapid bus service while development of the LRT system is underway.

The northern and southern portions of the corridor between downtown Scottsdale and Scottsdale Airpark in the north and between the CP/EV and Chandler Boulevard in the south are more suited for long-term implementation of full high capacity transit service. As LRT or Dedicated BRT service is implemented in the central portion of the Scottsdale Road/UP Tempe Branch corridor, rapid bus services connecting the northern and southern ends of the corridor with the central portion would be justified. Rapid bus service would be adequate to serve projected demand until the later portions of the planning horizon when more developed high capacity transit services would be warranted. The northern and southern portions of the Scottsdale Road/UP Tempe Branch corridor would likely serve a lower level of ridership than the central portion, potentially making Dedicated BRT service more efficient at serving this estimated demand.

SR-51

Traffic congestion in the SR-51 corridor is already high because of a lack of parallel routes through the Phoenix Mountains preserve. This existing congestion warrants the SR-51 corridor's inclusion as a near-term corridor. High capacity transit service in the initial phases would be provided by Express BRT services serving park-and-ride facilities in the corridor. This service would then be expanded to either Dedicated BRT or LRT service. If BRT service is chosen as a possible technology, on-line stations in the freeway medians should studied to improve operation of transit service in this corridor. In this scenario stations are constructed below street overpasses in the median of the freeway and are served by BRT vehicles operating in HOV lanes. An example of this type of BRT service is present in Los Angeles on the Harbor Freeway Transitway that operates between the SR-91 and I-10 freeways.

UP Chandler Branch

Like the other LRT/Dedicated BRT corridors in the southeast MAG region, the UP Chandler Branch is recommended for longer term implementation as future employment population growth warrants. An important initial step in the development of high capacity transit service in this corridor will be a determination about using a portion of the Union Pacific right-of-way in the Chandler Industrial Branch, as opposed to a parallel north-south arterial such as Arizona Avenue. If this becomes the preferred alignment, discussions with UP should begin well in advance of such a decision. Intermediate steps in implementing high capacity transit service could include rapid bus service on arterial streets in the corridor and Express BRT service between downtown Mesa and the Chandler High Tech corridor. An important role of this corridor will be to provide a link between Chandler and the Mesa commuter rail station on the UP Southeast corridor, allowing more East Valley residents access to commuter rail.

UP Southeast

The UP Southeast commuter rail corridor is the longest of the three recommended commuter rail corridors at 31 miles. Existing development conditions in this corridor can be separated into two sections. The dense existing development exists from the proposed Gilbert station east to downtown Phoenix. This portion of the route represents a possible first phase for operating the Phase 1 level of service. Depending upon the time frame for implementation of commuter rail service, sufficient demand may not be present further east or south of the proposed Gilbert station. Once growth has occurred beyond Gilbert commuter rail service could then be expanded to Williams Gateway and Queen Creek. One likely scenario is the extension of service to Williams Gateway once reverse commute service is justified, in order to maximize the number of new riders attracted to the system.

Another aspect of phasing service in the UP Southeast corridor will be the establishment of midline stations. Specific stations that could warrant delayed implementation include East Tempe and Sky Harbor Airport. These stations have relatively low ridership levels making their initial benefit more limited. The opening of the Sky Harbor Airport station would be best suited for coordination with the proposed Sky Harbor people mover linking the airport and CP/EV LRT. East Tempe would be implemented if the downtown Tempe and downtown Mesa stations were unable to accommodate ridership demand efficiently.

UP Yuma

As is the case with the UP Southeast corridor, the timing of service in the UP Yuma corridor will determine if the full 31 miles should be operated initially. If service is implemented during the next 10 to 15 years, sufficient demand will not exist to extend this service to Buckeye. Goodyear would serve as a better terminus point for the first five to 10 years of service. Most of the new development in Buckeye is timed to occur in the period between 2020 and 2040, limiting the potential of commuter rail service during the near term. By operating commuter rail service only to Goodyear, the initial Phase 1 service could be implemented much more cost-effectively. High capacity transit service to Buckeye at this point would be provided by an Express BRT service that feeds into the Goodyear station. Five potential station areas have been identified along the UP Yuma corridor in this study. It is possible that additional stations could be warranted given future population growth in the southwestern MAG region. Possible additional sites could include Avondale, and midway between Goodyear and Buckeye. These would be longer term stations that would not be implemented until the intermediate phases of commuter rail service.

5.3.3 Prioritization of Corridors

The High Capacity Transit Plan is designed to be the first step in developing and prioritizing the recommended network of high capacity transit services in the MAG region.

This prioritization will continue at a more detailed level during the development of the MAG Regional Transportation Plan (RTP). One of the main objectives of the RTP will be to set out a specific prioritization of the transit corridors identified in the recommended network. This prioritization will be the result of additional analysis of population and employment projections, an estimation of expected funding availability, and extensive public consultation. The prioritization contained within this report is designed to be a guide for more detailed refinement during the development of the RTP in 2003.

The 16 corridors contained in the Recommended High Capacity Transit Network have been categorized into three groups for the purposes of prioritization. The key considerations in setting forth the prioritization recommendations for the High Capacity Transit network are both quantitative and qualitative. They include:

- Analysis of expected population growth levels and anticipated timing of this future growth: the study scope approaches the potential demand for the high capacity transit system at full build-out of population and employment for the MAG region. However there are major differences in the rates at which this growth will generate appropriate thresholds of ridership across the region and within the corridors. The study has undertaken a review of the latest DRAFT2 socioeconomic forecasts at Traffic Analysis Zone levels to assess the likely build up of ridership to targeted 2040 levels.

- Estimated ridership.
- Linkages to the committed network of high capacity transit: the high capacity transit network is intended to enhance regional mobility. As such, connectivity with other elements of the network, including those which are natural extensions of the LRT and BRT networks which are already funded (CP/EV LRT, Central Avenue/Phoenix BRT corridors) are a key consideration in identifying early gains from high capacity transit development.
- The cohesiveness of the overall network, ensuring that future corridors link to previously implemented corridors.

The three groups of corridors identified here have been classified as the Short-Term, Middle-Term, and Long-Term Implementation corridors. Assuming a 40 year horizon for the population and employment projections used in this report, the Short-Term corridors would likely be recommended for implementation during the next 15 years, while the Middle-Term corridors would be implemented within a 15-30 year time frame. The Long-Term corridors would complete the high capacity transit network during the final ten years of the study period (2030 to 2040). It is essential to note that these classifications are not permanent. They are designed as a guide for future refinement as part of the RTP process. Changes in population growth levels, timing, and the location of future growth would result in changes to the corridors contained in each level.

Implementation of Corridors

The corridors have been placed into the three implementation categories for several reasons, including their performance in the cost effectiveness and Benefit Cost analysis, the objective of creating an integrated regional high capacity transit network resulting from the connections these corridors provide to the planned CP/EV LRT, and the objective of bringing some form of high capacity transit service to as many areas of the MAG region as possible during the first half of the planning horizon period.

Table 5.3-1 presents an analysis of the each of the corridors using the qualitative and quantitative criteria outlined above.

Table 5.3-1 **Corridor Prioritization Ratings**

Corridor	Timing of Future Growth	Estimated Ridership	Cost Effectiveness/ Benefit Cost	Links to Base HCT Network	Benefit Above Planned Service
59th Avenue	Medium	Low	Low	Low	High
Bell Road	Medium	Low	Medium	Low	High

Corridor	Timing of Future Growth	Estimated Ridership	Cost Effectiveness/ Benefit Cost	Links to Base HCT Network	Benefit Above Planned Service
BNSF	Medium	Medium	Medium	Medium	High
Camelback Road	High	High	High	High	Medium
Central Avenue South	High	High	Medium	High	Medium
Chandler Boulevard	Low	Medium	Low	Low	High
Glendale Avenue	Medium	Medium	Low	Medium	High
I-10 West	High	High	High	High	High
Main Street	High	High	High	High	Medium
Metrocenter/I-17	High	High	High	High	Medium
Power Road	Low	Low	Low	Low	High
Scottsdale Road/UP Tempe Branch	Medium	Medium	Medium	High	Medium
SR-51	Medium	Medium	Medium	High	Medium
UP Chandler Branch	Medium	High	Medium	Medium	High
UP Southeast	Medium	Low	Medium	High	High
UP Yuma	Medium	Medium	High	Medium	High

These criteria and objectives have resulted in the following recommendations for the Potential Short-Term corridors:

- BNSF (Start-up Phase – Downtown Phoenix to Bell Road)
- Camelback Road
- Glendale Avenue
- I-10 West
- Main Street
- Metrocenter/I-17
- Scottsdale Road/UP Tempe Branch (Downtown Scottsdale to CP/EV LRT)
- SR-51 (Central Avenue to Cactus Avenue)
- UP Southeast (Start-up)
- UP Yuma (Start-up)

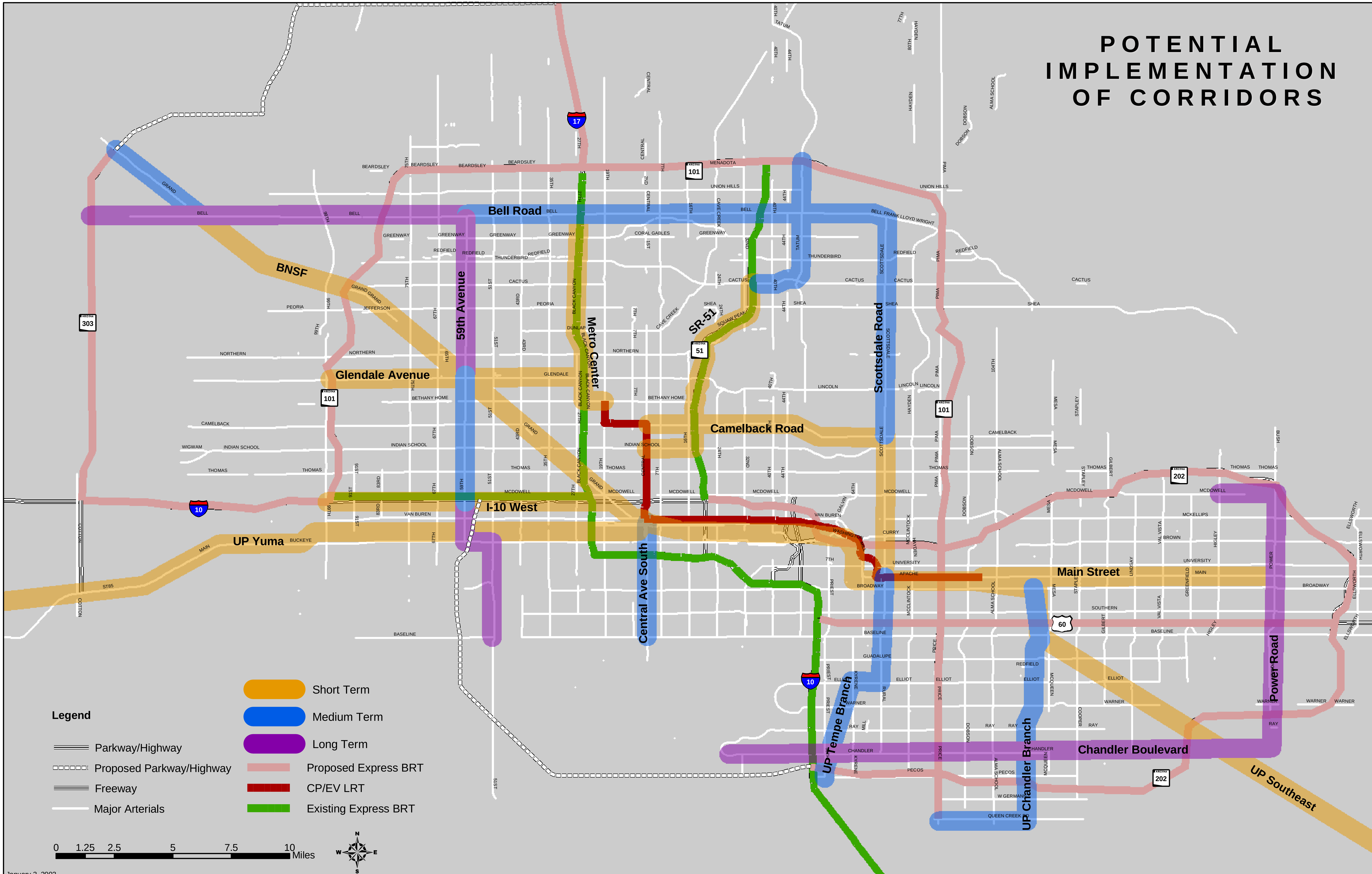
The Middle-Term corridors have been placed into this category for several reasons including slightly lower scores in the cost effectiveness evaluation when compared to the Short-Term corridors, later timing for population growth, and a need to allow for the implementation of other corridor to ensure linkages to the overall regional high capacity transit network. The Middle-Term corridors are:

- 59th Avenue (Glendale Avenue to I-10 West)
- Bell Road (Scottsdale Road to 59th Avenue)
- BNSF (Start-up to Loop 303, Ultimate to Bell Road)
- Central Avenue South
- Scottsdale Road/UP Tempe Branch (North of downtown Scottsdale and south of CP/EV LRT)
- SR-51 (Cactus Avenue to Loop 101)
- UP Chandler Branch
- UP Southeast (Start-up with reverse commute to Williams Gateway)
- UP Yuma (Ultimate)

The Long-Term corridors are classified as such because of the timing of future growth during the outlying years of the study horizon. Earlier implementation of these corridors would not be cost effective due to the lower ridership base that would be available. The corridors are:

- 59th Avenue (Bell Road to Glendale Avenue and I-10 West to Baseline Road)
- Bell Road (59th Avenue to Loop 303)
- BNSF (Ultimate to Loop 303)
- Chandler Boulevard
- Power Road
- UP Southeast (Ultimate)

There are recommendations for phased implementation of several of the corridors listed above. The characteristics of these phased implementations are described in Section 5.3.2 above. Specifically, the commuter rail corridors will require phased implementation and a period of time in which to build ridership and upgrade the existing rail infrastructure. The Scottsdale Road/UP Tempe Branch corridor is recommended for implementation in two phases as a result of the higher existing congestion and density between downtown Scottsdale and the planned CP/EV alignment. Similarly, the Bell Road and 59th Avenue corridors have segments which will call for implementation early on to meet expected population and employment growth. These shorter segments are designed to provide linkages to other high capacity transit corridors recommended for implementation either prior to or in conjunction with these segments. Growth in the remaining portions of these corridors further out in the future, allowing for some delay in implementing service. Exhibit 5.3-1 illustrates the corridors with of the recommended stages of development as part of the Recommended High Capacity Transit Network.


POTENTIAL IMPLEMENTATION OF CORRIDORS
Bell Road
BNSF
59th Avenue
Metro Center
SR-51
Scottsdale Road
Glendale Avenue
Camelback Road
I-10 West
UP Yuma
Central Ave South
Main Street
Power Road
UP Tempe Branch
UP Chandler Branch
Chandler Boulevard
UP Southeast
Legend
Short Term
Medium Term
Long Term
Parkway/Highway
Proposed Parkway/Highway
Freeway
Major Arterials
Proposed Express BRT
CP/EV LRT
Existing Express BRT
0 1.25 2.5 5 7.5 10
Miles
January 3, 2003
Potent Implement of corriodrs 3 levels

5.3.4 Technology Comparison

The Benefit Cost analysis presented in Section 5.1.3 includes a comparison of LRT and BRT technologies on two of the recommended high capacity transit corridors, Main Street and 59th Avenue. This comparison is primarily related to the overall cost for each project as actual differences in ridership are not available given the sketch planning model's limitations in distinguishing between the two technologies. From a cost standpoint BRT would likely provide more benefit than LRT in a specific corridor. However, there are other issues including ridership, frequency of service, and overall capacity that also must be considered before a recommended technology can be selected. In high ridership corridors, LRT may be the preferred technology based upon meeting ridership demand even if there are higher capital costs involved.

The US General Accounting Office (GAO) published a report to the US Congress in September 2001 comparing LRT and BRT technologies for the purposes for evaluating future transit projects applying for Federal funding assistance. This report analyzed the capital and operating costs of both technologies as well as the real-world performance of each technology.

In terms of capital cost, the GAO report found that BRT has a decided advantage over LRT[5]. BRT systems surveyed in cities through the United States reported capital costs ranging from $200,000 to $55 million per mile depending upon whether the system was implemented in mixed-flow vehicle traffic or in an exclusive right-of-way. LRT systems reported an average cost of $12.4 million to $118.8 million per mile. This difference in cost correlates well with the capital cost estimates contained in Section 5.1 of this report. The Dedicated BRT corridors have an average per mile capital cost of $18.1 million, while the LRT corridors' average per mile cost is $39.7 million.

The GAO report did not reveal a major advantage for either technology in terms of operating costs. BRT typically will require more vehicles and shorter headways to provide a comparable level of service to LRT. This increased service reduces or eliminates any advantage in operating cost that a single bus would have over a single LRT train. Long term maintenance and vehicle replacement costs may favor LRT over BRT since LRT vehicles have a life cycle that is approximately double that of standard buses. The track infrastructure for LRT also usually maintains a longer life cycle than a paved BRT guideway. The annual operating costs presented for BRT and LRT in this report tend to slightly favor BRT technology. However, these planning level costs and a detailed refinement of headways and infrastructure replacement in specific corridors could eliminate this slight advantage.

[5] GAO Report: Bus Rapid Transit Shows Promise, September 2001.

In terms of operational characteristics BRT and LRT both have advantages and disadvantages that would need to be analyzed on a corridor-by-corridor basis in order to determine the right technology "fit" for new high capacity transit system. A detailed Major Investment Study (MIS), similar to the one performed by the Cities of Scottsdale and Tempe for a north-south transit corridor, is required to fully and properly analyze each technology for a corridor. The discussion that follows presents the general advantages and disadvantages of each technology on a non-corridor specific basis.

Bus Rapid Transit

<u>Advantages</u>

BRT systems offer more flexibility in terms of implementation style given the technology's ability to operate in several environments from arterial streets, to high occupancy vehicle (HOV) lanes, to dedicated bus lines, and to exclusive rights-of-way. Depending upon the type of implementation BRT systems can expand or reduce capacity quickly, and routing can be adjusted to conform to changing land use or employment patterns.

As discussed above, BRT is much more flexible in terms of phased implementation. The first step can be a very basic rapid bus concept similar to what has been implemented in Los Angeles. The Wilshire Rapid Bus service is simple in design, but this service has the highest ridership level of any BRT system in the United States with approximately 70,000 daily riders. This figure exceeds ridership levels on several West Coast LRT systems. BRT was determined to be a better technology for the Wilshire corridor because of the high level of existing development and the prohibitive cost of acquiring right-of-way to implement light rail. The Rapid Bus service was implemented with no need for additional right-of-way, eliminating impacts to land uses in the corridor. Future phases of this project call for an exclusive bus line on Wilshire once sufficient funding is available. The advantage of BRT is this case was that a basic enhanced bus service was capable of being implemented in a short time frame and is providing benefits to the corridor equal to what an LRT system could provide with a shorter implementation time and a substantially lower cost.

Another advantage of BRT is its ability to operate as a temporary improvement until a larger transit service can be constructed and opened. BRT could be implemented in a corridor selected to provide LRT service prior to and during construction of the LRT system. The BRT service would provide enhanced service early on and begin to develop new ridership in corridor that would then transfer to the LRT service. Once the LRT service begins operations, the BRT vehicles can be relocated to another corridor or returned to regular local bus service, likely on routes feeding the LRT line.

Disadvantages

The primary disadvantage of BRT systems is the image held by many Americans that buses are slow, crowded, and dirty. This negative image is difficult to overcome, particularly in metropolitan areas with a limited history of transit service. There may be cases where an LRT system providing the exact level of service to a BRT system in the same corridor would be more likely to attract a higher number of riders due to the positive image many people have of LRT trains compared to buses. Many residents in transit corridors also have concerns about pollution and noise resulting from increased bus service. These negative attributes of buses are declining thanks to new alternative fuel technologies and quieter engines. Extensive public outreach and consultation is needed during the development of a high capacity transit service to understand the concerns of residents in the selected corridors. In some cases, community support or the lack of it may preclude the implementation of BRT service in a specific corridor.

An additional disadvantage of BRT service is the reduced capacity of the BRT vehicles compared to LRT vehicles. An average BRT vehicle capacity is 40 to 60 seated people, while LRT vehicles can hold approximately 150 people. This capacity advantage is magnified when standing capacity is considered. The reduced capacity of BRT vehicles usually requires that BRT systems offer more frequent service than LRT systems. This can increase rider convenience with shorter wait times, but increases maintenance costs due to roadway impacts and earlier replacement of BRT vehicles. These increased costs are a major reason in the similarity of operating costs between BRT and LRT.

Light Rail

Advantages

While the permanent nature of LRT can be a disadvantage in terms of phased implementation and future flexibility, this characteristic is turned into an advantage from a land use and economic development standpoint. LRT usually has a positive impact upon land use within a new transit corridor since it provides major new transportation infrastructure and capacity that is permanent. Similar to the effect that a new road or freeway has upon new development, LRT can spur new growth and inject new development energy into a corridor. The new growth is usually more positive than that generated by a freeway in that development is more dense and is designed to promote transit use and walking, reducing automobile impacts.

BRT is not as capable of generating economic growth because of its flexibility. This flexibility does not impart a sense of security that the transportation capacity will always be present. There is no sense of permanence. This effect can be mitigated with the development of an exclusive busway, but still may not be able to equal the benefits of LRT.

Another advantage of LRT is the increased capacity of the technology when compared to BRT. LRT would likely be the recommended technology for corridors with very high ridership in order to meet existing demand and future growth.

Disadvantages

The primary disadvantage of LRT is its limited ability for phased implementation. There is a high initial capital investment required to construct a new LRT system that can place constraints upon a transit agency's or city's ability to implement the system when demand for transit warrants service. This effect can be diminished when the gap between beginning construction and completion of the LRT system is bridged with the use of rapid bus service in the corridor.

Another disadvantage mentioned above is the higher capital investment required to implement LRT service. The increased cost is primarily an issue in situations where limited funding is available. BRT would be more capable of providing cost-effective service in a constrained funding environment.

Summary

Both transit technologies have a series of advantages and disadvantages that require analysis at a detailed corridor specific level to determine the appropriate technology for implementation. During the technology selection process it is important to consider the influence of other corridors in the regional recommended network. Each of these technologies is highly scalable and the implementation of one technology tends to encourage the continuation of that technology in future expansions and extensions of the initial corridor. This trend is a result of the economies of scale gained for expanding existing infrastructure and the possible negative effects on total ridership caused by bus-rail transfers. However, selecting one technology over the other does not preclude the implementation of both LRT and BRT in the same metropolitan region. These two technologies co-exist in many regions including Los Angeles, Pittsburgh, and Cleveland. In the end, technology selection is not only a local decision, it is a regional one that should include input from all stakeholders region-wide to order to bring the greatest benefit to the largest number of people.

5.3.5 Action Plan

The Recommended High Capacity Transit Network represents the culmination of a process that identified 28 potential high capacity transit corridors throughout the MAG region, refined these corridors, and evaluated them to determine which corridors were best suited to serve growing demand for transportation capacity in the MAG region.

The next step in implementing the recommended network is the inclusion of these corridors in the development of the RTP. This study was the first step in the process of implementation. The next step is the RTP process, which will involve a second review of the network corridors, a review of expect funding availability for transit improvements, and consultations with local agencies and the general public to further refine the number and coverage of the recommended corridors. This second review should result in a more precise prioritization of the corridors based upon further refined population projections, anticipated funding, and local agency support.

There are several specific next steps that need to be taken by MAG or local agencies in the MAG region either individually or in concert to ensure that proper preparations are made for providing future high capacity transit service in several of the corridors identified in the Recommended High Capacity Transit Network. Ideally these actions would begin immediately; however, given the need for approval of the RTP and its funding plan, some components may need to wait until the RTP is finalized. The tasks below are designed to be realistic objectives capable of being accomplished during the next three to five years. If these tasks are not completed in this timeframe, delays may be caused to later implementation steps and could delay components of the recommended network. The immediate actions are:

Refined Prioritization of Corridors in the RTP – The RTP process may introduce changes to the prioritization categories presented in Section 5.3.3 above. These changes must be determined early on so that local agencies understand the timing for funding availability and future implementation. The identification of future funding levels and funding sources during the development of the RTP is essential to determining an implementation schedule for the 15 corridors recommended for inclusion in the High capacity Transit Network.

Relocation of the BNSF Freight Facilities – BNSF has been considering the relocation and consolidation of several freight rail facilities in downtown Phoenix to sites north of the BNSF mainline north of the existing intermodal facility in El Mirage. This relocation would result in a reduction of freight switching activity in the BNSF corridor between Surprise and Phoenix, corresponding to the portion of the corridor recommended for commuter rail service. The elimination of this activity could create an opportunity for the negotiation of peak period operating windows to run the Phase 1 level of service in the BNSF corridor. The use of operating windows would substantially reduce the initial capital costs of implementing commuter rail service in the BNSF corridor, delaying the addition of a second main track until later phases of service.

The relocation of the BNSF facility is not a simple process and will require extensive consultations between BNSF, local cities in the corridor, MAG, the Federal Railroad Administration (FRA), and the general public. This will likely be a long process for gaining approval of all parties involved and the identification of funding. This time frame makes it imperative that discussions begin soon to determine the feasibility of this strategy. If the freight facility is not relocated, commuter rail service in the corridor will require a second main track, requiring time for the identification of funding sources and accumulation of sufficient funding.

Begin Negotiations with Union Pacific – Negotiating access rights to freight railroad corridors can be a long drawn-out process that lasts for as many as five to 10 years depending upon the railroad, the local agency, and the operating characteristics of the corridor. It will be important to have a full understanding of what types of access rights UP will allow in both the UP Yuma and UP Southeast corridors in order to determine what capital costs will be involved in possible track upgrades and additions.

Develop a Specific Commuter Rail Network Plan – Previous studies have already considered commuter rail, largely on a corridor basis, but not in the context of the High Capacity Transit network. The revised Milestone analysis of Commuter Rail suggests very attractive ridership performance for the Startup Phase of commuter rail. The High Capacity Transit Study level of analysis does not allow this conclusion to be tested rigorously as part of a standalone Commuter Rail Analysis. A separate action-oriented plan is needed to assess the viability of the startup service, take forward the initial discussions with UP and BNSF during the course of the High Capacity Transit Study, and run the network assumptions through an analysis based on the FTA New Starts criteria.

Perform Detailed Major Investment Studies on Early Implementation Corridors – Each corridor contained within the Recommended High Capacity Transit Network will require some form of Major Investment Study (MIS) to determine precise alignments, operating characteristics, preferred technology, and the overall design of the system. An MIS report includes a detailed refinement of costs, headways, and alignments, while including opportunities for community and policy input into the development of transit service. The outcome of an MIS is usually a more defined picture of what the high capacity transit service will look like in appear and operation. Several of these MIS efforts are underway or in early planning stages and include the Scottsdale-Tempe North-South Transit MIS and the City of Chandler Transit MIS, and this recommendation is not intended to be duplicative of these efforts. The work being done in these studies was incorporated into the development of corridors for evaluation in this report. Future MIS reports will build upon the corridors identified in the Recommended High Capacity Transit Network.

Appendix A

Commuter Rail Capital Cost Estimate
Burlington Northern Santa Fe

			Phase 1	Phase 3
Alignment Breakdown				
Surface (main track)	linear foot		138,230	15,840
Surface (sidings)	linear foot		2,000	4,000
Bridges	each		2	
Street Crossings	each		51	15
Freeway Crossings	each			
Total Ft				
Item	**Units**	**Avg. Unit Cost**	***Phase 1***	***Phase 3***
Sound Wall	linear foot	$137	$0	$0
Grade Separations (undercrossing)	Each	$15,000,000	$0	$0
Grade Separations (overcrossing)	Each	$12,000,000	$0	$0
Earthwork	linear foot	$2	$1,402,304	$198,400
New At-grade crossing	Each	$250,000	$4,250,000	$0
Close existing crossing	Each	$140,000	$420,000	$0
Waterway Crossing	linear foot	$10,000	$5,000,000	$0
Flood Control Crossing	linear foot	$10,000	$1,000,000	$0
Subtotal-Civil			**$12,072,304**	**$198,400**
Utility Relocation	Linear ft	$165	$23,138,016	$3,273,600
Subtotal-Utilities			**$23,138,016**	**$3,273,600**
Track (ballasted)	linear foot	$145	$19,593,908	$2,659,300
Street Crossing	linear foot	$2,000	$10,200,000	$3,000,000
Special Trackwork	%	15%	$2,939,086	$398,895
Crossover - Single	Each	$150,000	$600,000	$600,000
Subtotal-Track			**$33,332,994**	**$6,658,195**
Mid-Line Stations	Each	$2,000,000	$8,000,000	$0
Transit Hub Station	Each	$4,000,000	$8,000,000	$0
Central Terminal	Each	$10,000,000	$10,000,000	$0
Surface Parking	Space	$2,800	$3,472,000	$15,414,000
Parking Structures	Space	$9,500	$0	$0
Elevated Ped Xings	Each	$1,000,000	$0	$0
Ticket Vending Machines	Each	$65,000	$910,000	$0
Subtotal-Stations			**$30,382,000**	**$15,414,000**
Centralized Traffic Control	linear foot	$140	$0	$22,969,856
CTC Control Point	each	$750,000	$0	$4,500,000
Signal Control and Switch points	each	$100,000	$0	$800,000
Subtotal-C&S			**$0**	**$28,269,856**
Maintenance/Storage	Lump Sum	$22,000,000	$0	$22,000,000
Operations Control	Mile	$100,000	$2,620,000	$0
Subtotal Facilities			**$2,620,000**	**$22,000,000**
A. Construction Subtotal			**$101,545,314**	**$75,814,051**
Environmental Mitigation	Percent of A	2%	$2,030,906	$1,516,281
B. Construction Cost Subtotal			**$103,576,220**	**$77,330,332**
Maintenance/Storage Yard	square foot	$25	$0	$22,869,000
System Envelope	mile	$2,200,000	$0	$57,596,000
New Parking Spaces	square foot	$25	$10,802,875	$47,959,550
C. Right of Way Subtotal			**$10,802,875**	**$128,424,550**
Revenue Vehicles (cab car, bi-level, 135 pass)	Each	$3,000,000	$12,000,000	$21,000,000
Revenue Vehicles (non cab, bi-level, 135 pass.)	Each	$2,000,000	$36,000,000	$28,000,000
Revenue Vehicles (loco)	Each	$4,000,000	$16,000,000	$28,000,000
Spare Parts	Percent	10%	$6,400,000	$7,700,000
MOW Equipment	Rt Mile	$250,000	$6,545,000	$750,000
D. Vehicles Subtotal			**$76,945,000**	**$85,450,000**
Cost Contingencies (Uncertainties, Changes)				
Design&Construction	Percent of B	25%	$25,894,055	$19,332,583
Right of Way	Percent of C	30%	$3,240,863	$38,527,365
Vehicle Cost	Percent of D	10%	$7,694,500	$8,545,000
Program Implementation (Agency Costs and Fees)				
Design&Construction	Percent of B	31%	$32,108,628	$23,972,403
Right of Way Purchase	Percent of C	15%	$1,620,431	$19,263,683
Vehicle Procurement	Percent of D	5%	$3,847,250	$4,272,500
E. Capital Cost Subtotal			**$265,729,823**	**$405,118,415**
Project Reserve	Percent of E	10%	$26,572,982	$40,511,842
F. Total Capital Cost			**$292,302,805**	**$445,630,257**

$737,933,062

Commuter Rail Capital Costs
Union Pacific Mainline/Chandler Corridor

			Phase 1	***Phase 3***
Alignment Breakdown				
Surface (main track)	linear foot		78,936	14,889
Upgraded Track			45,461	
Surface (siding)	linear foot		0	4,000
Bridges	each			
Street Crossings	each		49	5
Item	**Units**	**Avg. Unit Cost**	***Phase 1***	***Phase 3***
Sound Wall	linear foot	$137	$3,616,800	$0
Grade Separations (undercrossing)	Each	$15,000,000	$0	$0
Grade Separations (overcrossing)	Each	$12,000,000	$0	$0
Earthwork	linear foot	$2	$789,360	$188,890
New At-grade crossing	Each	$250,000	$2,500,000	$0
Close existing crossing	Each	$140,000	$0	$0
Waterway Crossing	linear foot	$10,000	$13,200,000	$0
Flood Control Crossing	linear foot	$10,000	$3,000,000	$0
Subtotal-Civil			**$23,106,160**	**$188,890**
Utility Relocation	linear foot	$165	$13,024,440	$3,116,685
Subtotal-Utilities			**$13,024,440**	**$3,116,685**
Track	linear foot	$145	$10,735,220	$2,666,405
Upgrade Track	linear foot	$120	$5,455,296	$0
Street Crossing	linear foot	$2,000	$9,800,000	$1,000,000
Special Trackwork	%	15%	$1,610,283	$399,961
Crossover - Single	Each	$150,000	$600,000	$600,000
Subtotal-Track			**$28,200,799**	**$4,666,366**
Mid-Line Stations	Each	$2,000,000	$10,000,000	$0
Transit Hub Station	Each	$4,000,000	$8,000,000	$0
Central Terminal	Each	$10,000,000	$10,000,000	$0
Surface Parking	Space	$2,800	$2,240,000	$3,570,000
Parking Structures	Space	$9,500	$0	$0
Elevated Ped Xings	Each	$1,000,000	$0	$0
Ticket Vending Machines	Each	$65,000	$1,040,000	$0
Subtotal-Stations			**$31,280,000**	**$3,570,000**
Centralized Traffic Control	linear foot	$140	$13,135,584	$9,008,972
CTC Control Point	each	$750,000	$2,250,000	$1,500,000
Signal Control and Switch points	each	$100,000	$400,000	$400,000
Subtotal-C&S			**$15,785,584**	**$10,908,972**
Maintenance/Storage	Each	$15,000,000	$0	$15,000,000
Operations Control	Mile	$100,000	$2,800,000	$0
Subtotal Facilities			**$2,800,000**	**$15,000,000**
A. Construction Subtotal			**$114,196,983**	**$37,450,913**
Environmental Mitigation	Percent of A	2%	$2,283,940	$749,018
B. Construction Cost Subtotal			**$116,480,923**	**$38,199,931**
Maintenance/Storage Yard	Lump	$25	$0	$16,335,000
System Envelope	mile	$2,200,000	$0	$39,094,000
New Parking Spaces	square foot	$25	$6,969,600	$11,107,800
C. Right of Way Subtotal			**$6,969,600**	**$66,536,800**
Revenue Vehicles (cab car, bi-level, 135 pass)	Each	$3,000,000	$12,000,000	$21,000,000
Revenue Vehicles (non cab, bi-level, 135 pass.)	Each	$2,000,000	$8,000,000	$14,000,000
Revenue Vehicles (loco)	Each	$4,000,000	$16,000,000	$28,000,000
Spare Parts	Percent	10%	$3,600,000	$6,300,000
MOW Equipment	Rt Mile	$250,000	$6,987,500	$750,000
D. Vehicles Subtotal			**$46,587,500**	**$70,050,000**
Cost Contingencies (Uncertainties, Changes)				
Design&Construction	Percent of B	25%	$29,120,231	$9,549,983
Right of Way	Percent of C	30%	$2,090,880	$19,961,040
Vehicle Cost	Percent of D	10%	$4,658,750	$7,005,000
Program Implementation (Agency Costs and Fees)				
Design&Construction	Percent of B	31%	$36,109,086	$11,841,979
Right of Way Purchase	Percent of C	15%	$1,045,440	$9,980,520
Vehicle Procurement	Percent of D	5%	$2,329,375	$3,502,500
E. Capital Cost Subtotal			**$245,391,784**	**$236,627,752**
Project Reserve	Percent of E	10%	$24,539,178	$23,662,775
F. Total Capital Cost			**$269,930,963**	**$260,290,528**

Note: All costs are in Year 2001 Dollars

Commuter Rail Capital Costs
Union Pacific Southeast

			Phase 1	Phase 3
Alignment Breakdown				
Surface (main track)	linear foot		78,936	14,890
Surface (siding)	linear foot			18,560
Bridges	each		1	
Street Crossings	each		34	4
Freeway Crossings	linear foot			
Total Ft				
Item	**Units**	**Avg. Unit Cost**	**Phase 1**	**Phase 3**
Sound Wall	linear foot	$137	$4,340,160	$0
Grade Separations (undercrossing)	Each	$15,000,000	$0	$0
Grade Separations (overcrossing)	Each	$12,000,000	$0	$0
New At-grade crossing	Each	$250,000	$3,500,000	$0
Close existing crossing	Each	$140,000	$0	$0
Earthwork	linear foot	$2	$789,360	$334,500
Waterway Crossing	linear foot	$10,000	$13,200,000	$0
Flood Control Crossing	linear foot	$10,000	$3,000,000	$0
Subtotal-Civil			**$24,829,520**	**$334,500**
Utility Relocation	linear ft	$165	$13,024,440	$903,150
Subtotal-Utilities			**$13,024,440**	**$903,150**
Track	linear foot	$145	$10,952,720	$4,792,250
Street Crossing	linear foot	$2,000	$6,800,000	$800,000
Special Trackwork	%	15%	$1,642,908	$718,838
Crossover - Single	Each	$150,000	$300,000	$1,200,000
Subtotal-Track			**$19,695,628**	**$7,511,088**
Mid-Line Stations	Each	$2,000,000	$10,000,000	$0
Transit Hub Station	Each	$4,000,000	$8,000,000	$0
Central Terminal	Each	$10,000,000	$10,000,000	$0
Surface Parking	Space	$2,800	$2,478,000	$5,124,000
Parking Structures	Space	$9,500	$0	$0
Elevated Ped Xings	Each	$1,000,000	$0	$0
Ticket Vending Machines	Each	$65,000	$1,040,000	$0
Subtotal-Stations			**$31,518,000**	**$5,124,000**
Centralized Traffic Control	linear foot	$140	$13,135,584	$15,105,720
CTC Control Point	each	$750,000	$2,250,000	$3,000,000
Signal Control and Switch points	each	$100,000	$200,000	$800,000
Subtotal-C&S			**$15,585,584**	**$18,905,720**
Maintenance/Storage	Lump Sum	$17,000,000	$0	$17,000,000
Operations Control	Mile	$100,000	$3,620,000	$0
Subtotal Facilities			**$3,620,000**	**$17,000,000**
A. Construction Subtotal			**$108,273,172**	**$49,778,458**
Environmental Mitigation	Percent of A	2%	$2,165,463	$995,569
B. Construction Cost Subtotal			**$110,438,635**	**$50,774,027**
Maintenance/Storage Yard	square foot	$25	$0	$18,513,000
System Envelope	mile	$2,200,000	$0	$39,094,000
New Parking Spaces	square foot	$25	$7,715,325	$15,932,500
C. Right of Way Subtotal			**$7,715,325**	**$73,539,500**
Revenue Vehicles (cab car, bi-level, 135 pass)	Each	$3,000,000	$12,000,000	$24,000,000
Revenue Vehicles (non cab, bi-level, 135 pass.)	Each	$2,000,000	$14,000,000	$10,000,000
Revenue Vehicles (loco)	Each	$4,000,000	$16,000,000	$32,000,000
Spare Parts	Percent	10%	$4,200,000	$6,600,000
MOW Equipment	Rt Mile	$250,000	$7,967,500	$705,019
D. Vehicles Subtotal			**$54,167,500**	**$73,305,019**
Cost Contingencies (Uncertainties, Changes)				
Design&Construction	Percent of B	25%	$27,609,659	$12,693,507
Right of Way	Percent of C	30%	$2,314,598	$22,061,850
Vehicle Cost	Percent of D	10%	$5,416,750	$7,330,502
Program Implementation (Agency Costs and Fees)				
Design&Construction	Percent of B	31%	$34,235,977	$15,739,948
Right of Way Purchase	Percent of C	15%	$1,157,299	$11,030,925
Vehicle Procurement	Percent of D	5%	$2,708,375	$3,665,251
E. Capital Cost Subtotal			**$245,764,118**	**$270,140,528**
Project Reserve	Percent of E	10%	$24,576,412	$27,014,053
F. Total Capital Cost			**$270,340,529**	**$297,154,581**

Note: All costs are in Year 2001 Dollars

Commuter Rail Capital Cost Estimate
Union Pacific Yuma Corridor

			Phase 1	Phase 3
Alignment Breakdown				
Surface (main track)	linear foot		-	0
Surface (sidings)	linear foot		0	10,560
Bridges	each			
Street Crossings	each		0	2
Freeway Crossings	linear foot			
Total Ft				
Item	**Units**	**Avg. Unit Cost**	***Phase 1***	***Phase 3***
Sound Wall	linear foot	$137	$0	$1,808,400
Grade Separations (undercrossing)	Each	$15,000,000	$0	$0
Grade Separations (overcrossing)	Each	$12,000,000	$0	$0
Earthwork	linear foot	$2	$0	$105,600
New At-grade crossing	Each	$250,000	$1,250,000	$0
Close existing crossing	Each	$140,000	$0	$0
Waterway Crossing	linear foot	$10,000	$0	$0
Flood Control Crossing	linear foot	$10,000	$0	$0
Subtotal-Civil			**$1,250,000**	**$1,914,000**
Utility Relocation	Linear ft	$165	$0	$1,742,400
Subtotal-Utilities			**$0**	**$1,742,400**
Track (ballasted)	linear foot	$145	$0	$1,531,200
Street Crossing	linear foot	$2,000	$0	$400,000
Special Trackwork	%	15%	$0	$229,680
Crossover - Single	Each	$150,000	$0	$300,000
Subtotal-Track			**$0**	**$2,460,880**
Mid-Line Stations	Each	$2,000,000	$6,000,000	$0
Transit Hub Station	Each	$4,000,000	$4,000,000	$0
Central Terminal	Each	$10,000,000	$10,000,000	$0
Surface Parking	Space	$2,800	$3,416,000	$11,760,000
Parking Structures	Space	$9,500	$0	$0
Elevated Ped Xings	Each	$1,000,000	$0	$0
Ticket Vending Machines	Each	$65,000	$650,000	$0
Subtotal-Stations			**$24,066,000**	**$11,760,000**
Centralized Traffic Control	linear foot	$140	$0	$24,304,896
CTC Control Point	each	$750,000	$0	$3,750,000
Signal Control and Switch points	each	$100,000	$0	$400,000
Subtotal-C&S			**$0**	**$28,454,896**
Maintenance/Storage Yard	Lump Sum	$20,000,000	$0	$20,000,000
Operations Control	Mile	$100,000	$3,090,000	$0
Subtotal Facilities			**$3,090,000**	**$20,000,000**
A. Construction Subtotal			**$28,406,000**	**$66,332,176**
Environmental Mitigation	Percent of A	2%	$568,120	$1,326,644
B. Construction Cost Subtotal			**$28,974,120**	**$67,658,820**
Right-of-way for Maintenance/Storage Yard	square foot	$25	$0	$21,780,000
System Envelope	mile	$2,000,000	$0	$0
Right-of-way for Parking Spaces	square foot	$25	$10,637,350	$36,538,125
C. Right of Way Subtotal			**$10,637,350**	**$58,318,125**
Revenue Vehicles (cab car, bi-level, 135 pass)	Each	$3,000,000	$12,000,000	$21,000,000
Revenue Vehicles (non cab, bi-level, 135 pass.)	Each	$2,000,000	$20,000,000	$22,000,000
Revenue Vehicles (loco)	Each	$4,000,000	$16,000,000	$28,000,000
Spare Parts	Percent	10%	$4,800,000	$7,100,000
MOW Equipment	Mile	$250,000	$7,725,000	$500,000
D. Vehicles Subtotal			**$60,525,000**	**$78,600,000**
Cost Contingencies (Uncertainties, Changes)				
Design&Construction	Percent of B	25%	$7,243,530	$16,914,705
Right of Way	Percent of C	30%	$3,191,205	$17,495,438
Vehicle Cost	Percent of D	10%	$6,052,500	$7,860,000
Program Implementation (Agency Costs and Fees)				
Design&Construction	Percent of B	31%	$8,981,977	$20,974,234
Right of Way Purchase	Percent of C	15%	$1,595,603	$8,747,719
Vehicle Procurement	Percent of D	5%	$3,026,250	$3,930,000
E. Capital Cost Subtotal			**$130,227,535**	**$280,499,040**
Project Reserve	Percent of E	10%	$13,022,753	$28,049,904
F. Total Capital Cost			**$143,250,288**	**$308,548,944**

$451,799,232

BNSF Corridor Phase 1

CR - Fleet Sizing and O&M Estimate

Item			Comments
			peak headway **60** on each line
Travel/Track Miles of Line	26.18	26.18	
Stations:			
* Surface	see total -------------	7	
* Aerial	see total -------------	-	
Operating Times:			
* 1-way run, minutes	*48.3*		
Round trip w/o recovery (min)	97		excluding turn-around time at ends of line
* 2-way cycle, minutes	**97**		average cycle
Vehicle Fleet:			
* Trains in service (peak)	3	3	combined - 60' peak headways (H)
Pass Cars (6-car consist)	18	18	
* Cars in service (peak)	18	18	
* Fleet		22	In service + 20% spares
Train & Car Hrs & Miles:			
* Train Hours:			
- Daily	5	5	
* Car Hrs per day:			
- Base	5	5	
- Peak	25	25	
- Crush	0	-	
- Total	30	30	
* Car miles per day	942	942	
* Train miles per day	157		
* Annualization:			300 equivalent weekdays/year
- Car Hours	9,000	9,000	
- Car Miles	282,744	282,744	
O&M Cost Estimates:			
* Rev. Veh Hrs @ $487.64		$ 4.4	$ millions
* Rev Veh Mi @ $16.81		$ 4.8	$ millions
* ROW Lease @ $6.00/train mile		$ 0.3	$ millions
*** Total Annual O&M**		**$ 4.9**	$ millions

* Total Annual O&M Cost is computed using an average of the model inputs for revenue hours and revenue miles, plus the cost of lease track rights for Phase 1.

BNSF Corridor Phase 3

CR - Fleet Sizing and O&M Estimate

Item			Comments	
				peak
Travel/Track Miles of Line	26.18	26.18		headway
Stations:				15
* Surface	see total -------------	7		on each line
Operating Times:				
* 1-way run, minutes	*48.3*			
* 2-way cycle, minutes	**97**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	8	8	combined - 15' peak headways (H)	
Pass Cars (4-car consist)	32	32		
* Cars in service (peak)	32	32		
* Fleet		38	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Peak	29			
- Off-Peak	15			
- Total	44	44		
* Car Hrs per day:				
- Peak	116	116		
- Off-Peak	30	30		
- Crush	0	-		
- Total	146	146		
* Car miles per day	4,709	4,709		
* Peak Train miles per day	942			
* Off-Peak Train miles per day	471			
* Total Train miles per day	1,413			
* Annualization:			300 equivalent weekdays/year	
- Car Hours	43,800	43,800		
- Car Miles	1,412,775	1,412,775		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $487.64		$ 21.4	$ millions	
* Rev Veh Mi @ $16.81		$ 23.7	$ millions	
*** Total Annual O&M**		**$ 22.6**	$ millions	

* Total Annual O&M Cost is computed using an average of the model inputs for revenue hours and revenue miles.

UP Mainline/Chandler Corridor Phase 1
CR - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak
Travel/Track Miles of Line	25.95	25.95		headway
Stations:				**60**
* Surface	see total -------------	8		on each line
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*49.1*			
Round trip w/o recovery (min)	98		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**98**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	3	3	combined - 60' peak headways (H)	
Pass Cars (2-car consist)	6	6		
* Cars in service (peak)	6	6		
* Fleet		7	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	5	5		
* Car Hrs per day:				
- Base	5	5		
- Peak	10	10		
- Crush	0	-		
- Total	10	10		
* *Schedule* speed, mph	15.8		Includes dwell and recovery times	
* Car miles per day	311	311		
* Train miles per day	156			
* Annualization:			300 equivalent weekdays/year	
- Car Hours	3,000	3,000		
- Car Miles	93,420	93,420		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $487.64		$ 1.5	$ millions	
* Rev Veh Mi @ $16.81		$ 1.6	$ millions	
* ROW Lease @ $6.00/train mile		$ 0.3	$ millions	
*** Total Annual O&M**		**$ 1.9**	$ millions	

* Total Annual O&M Cost is computed using an average of the model inputs for revenue hours and revenue miles, plus the cost of lease track rights for Phase 1.

Up Mainline/Chandler Corridor Phase 3
CR - Fleet Sizing and O&M Estimate

Item			Comments
			peak
Travel/Track Miles of Line	25.95	25.95	headway
Stations:			15
* Surface	see total -------------	8	on each line
Operating Times:			
* 1-way run, minutes	*49.1*		
* 2-way cycle, minutes	**98**		average cycle
Vehicle Fleet:			
* Trains in service (peak)	9	9	combined - 15' peak headways (H)
Pass Cars (2-car consist)	18	18	
* Cars in service (peak)	18	18	
* Fleet		22	In service + 20% spares
Train & Car Hrs & Miles:			
* Train Hours:			
- Peak	30		
- Off-Peak	15		
- Total	45	45	
* Car Hrs per day:			
- Peak	60	60	
- Off-Peak	30	30	
- Crush	0	-	
- Total	90	90	
* Car miles per day	2,802	2,802	
* Peak Train miles per day	934		
* Off-Peak Train miles per day	467		
* Total Train miles per day	1,401		
* Annualization:			300 equivalent weekdays/year
- Car Hours	27,000	27,000	
- Car Miles	840,494	840,494	
O&M Cost Estimates:			
* Rev. Veh Hrs @ $487.64		$ 13.2	$ millions
* Rev Veh Mi @ $16.81		$ 14.1	$ millions
* ROW Lease @ $6.00/train mile		$ 0.6	$ millions
*** Total Annual O&M**		**$ 14.3**	$ millions

* Total Annual O&M Cost is computed using an average of the model inputs for revenue hours and revenue miles, plus the cost of leasing track rights along the Chandler Industrial Branch.

UP Southeast Corridor Phase 1

CR - Fleet Sizing and O&M Estimate

Item			**Comments**
			peak headway **60** on each line
Travel/Track Miles of Line	31.87	31.87	
Stations:			
* Surface	see total -------------	8	
Operating Times:			
* 1-way run, minutes	*56.2*		
* 2-way cycle, minutes	**112**		average cycle
Vehicle Fleet:			
* Trains in service (peak)	3	3	combined - 60' peak headways (H)
Pass Cars (3-car consist)	9	9	
* Cars in service (peak)	9	9	
* Fleet		11	In service + 20% spares
Train & Car Hrs & Miles:			
* Train Hours:			
- Daily	6	6	
* Car Hrs per day:			
- Base	6	6	
- Peak	12	12	
- Crush	0	-	
- Total	18	18	
* Car miles per day	574	574	
* Train miles per day	191		
* Annualization:			300 equivalent weekdays/year
- Car Hours	5,400	5,400	
- Car Miles	172,098	172,098	
O&M Cost Estimates:			
* Rev. Veh Hrs @ $487.64		$2.60	$ millions
* Rev Veh Mi @ $16.81		$2.90	$ millions
* ROW Lease @ $6.00/train mile		$0.30	$ millions
*** Total Annual O&M**		**$3.05**	$ millions

* Total Annual O&M Cost is computed using an average of the model inputs for revenue hours and revenue miles, plus the cost of lease track rights for Phase 1.

UP Southeast Corridor Phase 3
CR - Fleet Sizing and O&M Estimate

Item			Comments	
				peak headway
Travel/Track Miles of Line	31.87	31.87		15
Stations:				
* Surface	see total -------------	8		on each line
Operating Times:				
* 1-way run, minutes	*56.2*			
* 2-way cycle, minutes	**112**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	10	10	combined - 15' peak headways (H)	
Pass Cars (2-car consist)	20	20		
* Cars in service (peak)	20	20		
* Fleet		24	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Peak	34			
- Off-Peak	17			
- Total	51	51		
* Car Hrs per day:				
- Peak	68	68		
- Off-Peak	34	34		
- Crush	0	-		
- Total	102	102		
* Car miles per day	3,439	3,439		
* Peak Train miles per day	1,146			
* Off-Peak Train miles per day	573			
* Total Train miles per day	1,720			
* Annualization:			300 equivalent weekdays/year	
- Car Hours	30,600	30,600		
- Car Miles	1,031,832	1,031,832		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $487.64		$ 14.9	$ millions	
* Rev Veh Mi @ $16.81		$ 17.3	$ millions	
* ROW Lease @ $6.00/train mile		$ 1.4	$ millions	
*** Total Annual O&M**		**$ 17.5**	$ millions	

* Total Annual O&M Cost is computed using an average of the model inputs for revenue hours and revenue miles, plus the cost of lease track rights between Baseline Road and Ellsworth Avenue.

Up Yuma Corridor Phase 1

CR - Fleet Sizing and O&M Estimate

Item			**Comments**
			peak headway **60** on each line
Travel/Track Miles of Line	30.90	30.90	
Stations:			
* Surface	see total -------------	5	
Operating Times:			
* 1-way run, minutes	*46.1*		
* 2-way cycle, minutes	**92**		average cycle
Vehicle Fleet:			
* Trains in service (peak)	3	3	combined - 60' peak headways (H)
Pass Cars (4-car consist)	12	12	
* Cars in service (peak)	12	12	
* Fleet		14	In service + 20% spares
Train & Car Hrs & Miles:			
* Train Hours:			
- Daily	5	5	
* Car Hrs per day:			
- Base	5	5	
- Peak	15	15	
- Crush	0	-	
- Total	20	20	
* Car miles per day	742	742	
* Train miles per day	185		
* Annualization:			300 equivalent weekdays/year
- Car Hours	6,000	6,000	
- Car Miles	222,480	222,480	
O&M Cost Estimates:			
* Rev. Veh Hrs @ $487.64		$ 2.9	$ millions
* Rev Veh Mi @ $16.81		$ 3.7	$ millions
* ROW Lease @ $6.00/train mile		$ 0.3	$ millions
*** Total Annual O&M**		**$ 3.6**	$ millions

* Total Annual O&M Cost is computed using an average of the model inputs for revenue hours and revenue miles, plus the cost of lease track rights for Phase 1.

UP Yuma Corridor Phase 3

CR - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak
Travel/Track Miles of Line	30.90	30.90		headway
Stations:				**15**
* Surface	see total -------------	5		on each line
Operating Times:				
* 1-way run, minutes	*46.1*			
* 2-way cycle, minutes	**92**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	9	9	combined - 15' peak headways (H)	
Pass Cars (3-car consist)	27	27		
* Cars in service (peak)	27	27		
* Fleet		32	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Peak	28			
- Off-Peak	14			
- Total	42	42		
* Car Hrs per day:				
- Peak	84	84		
- Off-Peak	28	28		
- Crush	0	-		
- Total	112	112		
* Car miles per day	4,448	4,448		
* Peak Train miles per day	1,112			
* Off-Peak Train miles per day	556			
* Total Train miles per day	1,668			
* Annualization:			300 equivalent weekdays/year	
- Car Hours	33,600	33,600		
- Car Miles	1,334,318	1,334,318		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $487.64		$ 16.4	$ millions	
* Rev Veh Mi @ $16.81		$ 22.4	$ millions	
* ROW Lease @ $6.00/train mile		$ 3.0	$ millions	
*** Total Annual O&M**		**$ 22.4**	$ millions	

* Total Annual O&M Cost is computed using an average of the model inputs for revenue hours and revenue miles, plus the cost of lease track rights.

Appendix B

Light Rail Transit Estimated Costs
(Ballasted Track)

Item	Units	Avg. Unit Cost	Amount	*Bell Road*	*Amount*	*Chandler Boulevard*	*Amount*	*Power Road*
Alignment Breakdown								
Surface (Median)	linear ft			142,848		71,036		66,224
Surface (Rail ROW, Freeway)	linear ft							
Freeway/Bridge Crossings (Locations)	linear ft			7,920		15,840		2,640
Elevated (Aerial Locations)	linear ft							
Elevated/Special (Aerial Locations)	linear ft							
Street Crossings	each							
Intersections	each			100		68		45
Signal Intersections	each			69		45		35
Basic intersection traffic mitigation	Each	$53,000				$0		$0
Intersection Modifications (Spot widening)	Each	$320,000				$0		$0
Modify/Move Traffic Signals	Sig. Intrsctn	$65,000	69	$4,485,000	45	$2,925,000	35	$2,275,000
Roadway Widening	linear ft	$275	142,848	$39,283,200	71,036	$19,534,900	66,224	$18,211,600
New at-grade crossing (in freight railway)	Each	$265,000						
Civil/Roadway Modifications (at intersections)	linear ft	$230	10,000	$2,300,000	6,800	$1,564,000	4,500	$1,035,000
Subtotal-Civil Site Mods				**$46,068,200**		**$24,023,900**		**$21,521,600**
Surface Track Embedded in Street	linear ft	$472	10,000	$4,720,000	6,800	$3,209,600	4,500	$2,124,000
Surface Track Ballast	linear ft	$159	132,848	$21,122,832	64,236	$10,213,524	61,724	$9,814,116
Dual Track Aerial	Aerial Rt Ft	$4,000	7,920	$31,680,000	15,840	$63,360,000	2,640	$10,560,000
Long Span Aerial Structures	Aerial Rt Ft	$8,000						
Subtotal-Guideway				**$57,522,832**		**$76,783,124**		**$22,498,116**
Utility Relocation	Linear ft	$425	150,768	$64,076,400	86,876	$36,922,300	68,864	$29,267,200
Subtotal-Utilities				**$64,076,400**		**$36,922,300**		**$29,267,200**
Direct Fixation Track (on structure)	linear ft	$490	7,920	$3,880,800	15,840	$7,761,600	2,640	$1,293,600
Ballast Track (at-grade)	linear ft	$345	132,848	$45,832,560	64,236	$22,161,420	61,724	$21,294,780
Embedded Track (in pavement)	linear ft	$495	10,000	$4,950,000	6,800	$3,366,000	4,500	$2,227,500
Subtotal-Track				**$54,663,360**		**$33,289,020**		**$24,815,880**
Surface Stations	Each	$900,000	25	$22,500,000	12	$10,800,000	12	$10,800,000
Aerial Stations	Each	$3,000,000	2	$6,000,000	3	$9,000,000	0	$0
Hub Station (surface)	Each	$1,500,000	2	$3,000,000	2	$3,000,000	1	$1,500,000
Surface Parking	Space	$3,000	2,175	$6,525,000	1,275	$3,825,000	975	$2,925,000
Parking Structures	Space	$10,000	2,175	$21,750,000	1,275	$12,750,000	975	$9,750,000
Elevated Ped Xings	Each	$1,000,000	2	$2,000,000	3	$3,000,000	1	$1,000,000
Subtotal-Stations				**$61,775,000**		**$42,375,000**		**$25,975,000**
Ticket Vending Machines	Station	$390,000	29	$11,310,000	17	$6,630,000	13	$5,070,000
Substations	Each	$1,150,000	29	$33,350,000	17	$19,550,000	13	$14,950,000
Overhead Catenary	linear ft	$195	150,768	$29,399,760	86,876	$16,940,820	68,864	$13,428,480
Catenary Foundations	linear ft	$55	142,848	$7,856,640	71,036	$3,906,980	66,224	$3,642,320
Communications/Signals	linear ft	$245	150,768	$36,938,160	86,876	$21,284,620	68,864	$16,871,680
Crossover Interlockings	Each	$210,000	14	$2,940,000	8	$1,680,000	7	$1,365,000
Duct Bank - Aerial	Aerial Rt Ft	$37	7,920	$293,040	15,840	$586,080	2,640	$97,680
Duct Bank - At Grade	linear ft	$37	142,848	$5,285,376	71,036	$2,628,332	66,224	$2,450,288
Lighting At Grade	Surfc Rt Mile	$375,000	29	$10,706,250	16	$6,168,750	13	$4,875,000
Subtotal-Sys Electrical				**$138,079,226**		**$79,375,582**		**$62,750,448**
Maintenance/Storage	Each			$10,000,000		$5,000,000		$3,000,000
Operations Control	Each			$2,500,000		$2,500,000		$2,500,000
Subtotal - Facilities				**$12,500,000**		**$7,500,000**		**$5,500,000**
A. Construction Subtotal				**$434,685,018**		**$300,268,926**		**$192,328,244**
Environmental Mitigation	Percent of A	2%		$8,693,700		$6,005,379		$3,846,565
B. Construction Cost Subtotal				**$443,378,718**		**$306,274,305**		**$196,174,809**
System Envelope	square foot	$25	3,055,504	$76,387,600	1,477,428	$36,935,700	1,419,652	$35,491,300
New Parking Spaces	square foot	$25	1,010,592	$25,264,800	592,416	$14,810,400	453,024	$11,325,600
C. Right of Way Subtotal				**$101,652,400**		**$51,746,100**		**$46,816,900**
Revenue Vehicles	Each	$3,000,000	41	$123,000,000	17	$51,000,000	12	$36,000,000
Spare Parts	Percent	10%		$12,300,000		$5,100,000		$3,600,000
MOW Equipment	Rt Mile	$225,000	29	$6,412,500	16	$3,701,250	13	$2,925,000
D. Vehicles Subtotal				**$141,712,500**		**$59,801,250**		**$42,525,000**
Cost Contingencies (Uncertainties, Changes)								
Design&Construction	Percent of B	25%		$110,844,680		$76,568,576		$49,043,702
Right of Way	Percent of C	30%		$30,495,720		$15,523,830		$14,045,070
Vehicle Cost	Percent of D	10%		$14,171,250		$5,980,125		$4,252,500
Program Implementation (Agency Costs and Fees)								
Design&Construction	Percent of B	31%		$137,447,403		$94,945,034		$60,814,191
Right of Way Purchase	Percent of C	15%		$15,247,860		$7,761,915		$7,022,535
Vehicle Procurement	Percent of D	5%		$7,085,625		$2,990,063		$2,126,250
E. Capital Cost Subtotal				**$1,002,036,156**		**$621,591,198**		**$422,820,957**
Project Reserve	Percent of E	10%		$100,203,616		$62,159,120		$42,282,095.69
F. Total Capital Cost				**$1,102,239,771**		**$683,750,317**		**$465,103,053**

Note: All costs are in Year 2001 Dollars

Light Rail Transit Estimated Costs
(Ballasted Track)

Item	Units	Avg. Unit Cost	*Amount*	*SR-51*	*Amount*	*59th Avenue*	*Amount*	*I-10 West*
Alignment Breakdown								
Surface (Median)	linear ft			61,195		89,729		57,004
Surface (Rail ROW, Freeway)	linear ft							
Freeway/Bridge Crossings (Locations)	linear ft			3,960		5,280		
Elevated (Aerial Locations)	linear ft			26,400				1,340
Elevated/Special (Aerial Locations)	linear ft					5,280		
Street Crossings	each							
Intersections	each			37		106		15
Signal Intersections	each			24		54		10
Basic intersection traffic mitigation	Each	$53,000		$0		$0		$0
Intersection Modifications (Spot widening)	Each	$320,000		$0		$0		$0
Modify/Move Traffic Signals	Sig. Intrsctn	$65,000	24	$1,560,000	54	$3,510,000	10	$650,000
Roadway Widening	linear ft	$275	61,195	$16,828,625	89,729	$24,675,475	57,004	$15,676,100
New at-grade crossing (in freight railway)	Each	$265,000		$0		$0		$0
Civil/Roadway Modifications (at intersections)	linear ft	$230	3,700	$851,000	10,600	$2,438,000	1,500	$345,000
Subtotal-Civil Site Mods				**$19,239,625**		**$30,623,475**		**$16,671,100**
Surface Track Embedded in Street	linear ft	$472	3,700	$1,746,400	10,600	$5,003,200	3,940	$1,859,680
Surface Track Ballast	linear ft	$159	57,495	$9,141,705	79,129	$12,581,511	53,064	$8,437,176
Dual Track Aerial	Aerial Rt Ft	$4,000	30,360	$121,440,000	10,560	$42,240,000	1,340	$5,360,000
Long Span Aerial Structures	Aerial Rt Ft	$8,000						
Subtotal-Guideway				$132,328,105		**$59,824,711**		**$15,656,856**
Utility Relocation	Linear ft	$425	91,555	$38,910,875	100,289	$42,622,825	58,344	$24,796,200
Subtotal-Utilities				**$38,910,875**		**$42,622,825**		**$24,796,200**
Direct Fixation Track (on structure)	linear ft	$490	30,360	$14,876,400	10,560	$5,174,400	1,340	$656,600
Ballast Track (at-grade)	linear ft	$345	57,495	$19,835,775	79,129	$27,299,505	53,064	$18,307,080
Embedded Track (in pavement)	linear ft	$495	3,700	$1,831,500	10,600	$5,247,000	3,940	$1,950,300
Subtotal-Track				**$36,543,675**		**$37,720,905**		**$20,913,980**
Surface Stations	Each	$900,000	13	$11,700,000	15	$13,500,000	10	$9,000,000
Aerial Stations	Each	$3,000,000	4	$12,000,000	1	$3,000,000	0	$0
Hub Station (surface)	Each	$1,500,000	0	$0	3	$4,500,000	1	$1,500,000
Surface Parking	Space	$3,000	1,275	$3,825,000	1,425	$4,275,000	825	$2,475,000
Parking Structures	Space	$10,000	1,275	$12,750,000	1,425	$14,250,000	825	$8,250,000
Elevated Ped Xings	Each	$1,000,000	4	$4,000,000	2	$2,000,000	0	$0
Subtotal-Stations				**$44,275,000**		**$41,525,000**		**$21,225,000**
Ticket Vending Machines	Station	$390,000	17	$6,630,000	19	$7,410,000	11	$4,290,000
Substations	Each	$1,150,000	17	$19,550,000	19	$21,850,000	11	$12,650,000
Overhead Catenary	linear ft	$195	91,555	$17,853,225	100,289	$19,556,355	58,344	$11,377,080
Catenary Foundations	linear ft	$55	61,195	$3,365,725	89,729	$4,935,095	57,004	$3,135,220
Communications/Signals	linear ft	$245	91,555	$22,430,975	100,289	$24,570,805	58,344	$14,294,280
Crossover Interlockings	Each	$210,000	9	$1,890,000	9	$1,890,000	6	$1,260,000
Duct Bank - Aerial	Aerial Rt Ft	$37	30,360	$1,123,320	10,560	$390,720	1,340	$49,580
Duct Bank - At Grade	linear ft	$37	61,195	$2,264,215	89,729	$3,319,973	57,004	$2,109,148
Lighting At Grade	Surfc Rt Mile	$375,000	17	$6,502,500	19	$7,125,000	11	$4,125,000
Subtotal-Sys Electrical				**$81,609,960**		**$91,047,948**		**$53,290,308**
Maintenance/Storage	Each			$6,500,000		$5,000,000		$3,000,000
Operations Control	Each			$2,500,000		$2,500,000		$2,500,000
Subtotal - Facilities				$9,000,000		**$7,500,000**		**$5,500,000**
A. Construction Subtotal				**$361,907,240**		**$310,864,864**		**$158,053,444**
Environmental Mitigation	Percent of A	2%		$7,238,145		$6,217,297		$3,161,069
B. Construction Cost Subtotal				**$369,145,385**		**$317,082,161**		**$161,214,513**
System Envelope	square foot	$25	1,322,385	$33,059,625	1,819,967	$45,499,175	626,160	$15,654,000
New Parking Spaces	square foot	$25	592,416	$14,810,400	662,112	$16,552,800	383,328	$9,583,200
C. Right of Way Subtotal				**$47,870,025**		**$62,051,975**		**$25,237,200**
Revenue Vehicles	Each	$3,000,000	26	$78,000,000	19	$57,000,000	19	$57,000,000
Spare Parts	Percent	10%		$7,800,000		$5,700,000		$5,700,000
MOW Equipment	Rt Mile	$225,000	17	$3,901,500	19	$4,275,000	11	$2,475,000
D. Vehicles Subtotal				**$89,701,500**		**$66,975,000**		**$65,175,000**
Cost Contingencies (Uncertainties, Changes)								
Design&Construction	Percent of B	25%		$92,286,346		$79,270,540		$40,303,628
Right of Way	Percent of C	30%		$14,361,008		$18,615,593		$7,571,160
Vehicle Cost	Percent of D	10%		$8,970,150		$6,697,500		$6,517,500
Program Implementation (Agency Costs and Fees)								
Design&Construction	Percent of B	31%		$114,435,069		$98,295,470		$49,976,499
Right of Way Purchase	Percent of C	15%		$7,180,504		$9,307,796		$3,785,580
Vehicle Procurement	Percent of D	5%		$4,485,075		$3,348,750		$3,258,750
E. Capital Cost Subtotal				**$748,435,062**		**$661,644,785**		**$363,039,830**
Project Reserve	Percent of E	10%		$74,843,506.15		$66,164,479		$36,303,983.01
F. Total Capital Cost				**$823,278,568**		**$727,809,264**		**$399,343,813**

Note: All costs are in Year 2001 Dollars

Light Rail Transit Estimated Costs
(Ballasted Track)

Item	Units	Avg. Unit Cost	Amount	Union Pacific Chandler Branch	Amount	Main	Amount	Metrocenter
Alignment Breakdown								
Surface (Median)	linear ft			18,240		50,899		43,560
Surface (Rail ROW, Freeway)	linear ft			48,288		-		-
Freeway/Bridge Crossings (Locations)	linear ft							-
Elevated (Aerial Locations)	linear ft							2,640
Elevated/Special (Aerial Locations)	linear ft							
Street Crossings	each			24		-		-
Intersections	each			7		43		7
Signal Intersections	each			6		25		4
Basic intersection traffic mitigation	Each	$53,000		$0		$0		$0
Intersection Modifications (Spot widening)	Each	$320,000		$0		$0		$0
Modify/Move Traffic Signals	Sig. Intrsctn	$65,000	6	$390,000	25	$1,625,000	4	$260,000
Roadway Widening	linear ft	$275	18,240	$5,016,000	50,899	$13,997,225	43,560	$11,979,000
New at-grade crossing (in freight railway)	Each	$265,000	2	$530,000	0	$0	0	$0
Civil/Roadway Modifications (at intersections)	linear ft	$230	3,100	$713,000	4,300	$989,000	700	$161,000
Subtotal-Civil Site Mods				**$6,649,000**		**$16,611,225**		**$12,400,000**
Surface Track Embedded in Street	linear ft	$472	18,240	$8,609,280	4,300	$2,029,600	700	$330,400
Surface Track Ballast	linear ft	$159	48,288	$7,677,792	46,599	$7,409,241	42,860	$6,814,740
Dual Track Aerial	Aerial Rt Ft	$4,000	0	$0	0	$0	2,640	$10,560,000
Long Span Aerial Structures	Aerial Rt Ft	$8,000		$0		$0		$0
Subtotal-Guideway				**$16,287,072**		**$9,438,841**		**$17,705,140**
Utility Relocation	Linear ft	$425	66,528	$28,274,400	50,899	$21,632,075	46,200	$19,635,000
Subtotal-Utilities				**$28,274,400**		**$21,632,075**		**$19,635,000**
Direct Fixation Track (on structure)	linear ft	$490	0	$0	0	$0	2,640	$1,293,600
Ballast Track (at-grade)	linear ft	$345	48,288	$16,659,360	46,599	$16,076,655	42,860	$14,786,700
Embedded Track (in pavement)	linear ft	$495	18,240	$9,028,800	4,300	$2,128,500	700	$346,500
Subtotal-Track				**$25,688,160**		**$18,205,155**		**$16,426,800**
Surface Stations	Each	$900,000	11	$9,900,000	9	$8,100,000	7	$6,300,000
Aerial Stations	Each	$3,000,000	0	$0	0	$0	1	$3,000,000
Hub Station (surface)	Each	$1,500,000	2	$3,000,000	1	$1,500,000	0	$0
Surface Parking	Space	$3,000	975	$2,925,000	750	$2,250,000	600	$1,800,000
Parking Structures	Space	$10,000	975	$9,750,000	750	$7,500,000	600	$6,000,000
Elevated Ped Xings	Each	$1,000,000	0	$0	0	$0	1	$1,000,000
Subtotal-Stations				**$25,575,000**		**$19,350,000**		**$18,100,000**
Ticket Vending Machines	Station	$390,000	13	$5,070,000	10	$3,900,000	8	$3,120,000
Substations	Each	$1,150,000	13	$14,950,000	10	$11,500,000	8	$9,200,000
Overhead Catenary	linear ft	$195	66,528	$12,972,960	50,899	$9,925,305	46,200	$9,009,000
Catenary Foundations	linear ft	$55	66,528	$3,659,040	50,899	$2,799,445	43,560	$2,395,800
Communications/Signals	linear ft	$245	66,528	$16,299,360	50,899	$12,470,255	46,200	$11,319,000
Crossover Interlockings	Each	$210,000	6	$1,260,000	4	$840,000	4	$840,000
Duct Bank - Aerial	Aerial Rt Ft	$37	0	$0	0	$0	2,640	$97,680
Duct Bank - At Grade	linear ft	$37	66,528	$2,461,536	50,899	$1,883,263	43,560	$1,611,720
Lighting At Grade	Surfc Rt Mile	$375,000	13	$4,725,000	10	$3,600,000	9	$3,281,250
Subtotal-Sys Electrical				**$61,397,896**		**$46,918,268**		**$40,874,450**
Maintenance/Storage	Each			$4,750,000		$4,500,000		$2,500,000
Operations Control	Each			$2,500,000		$2,500,000		$1,000,000
Subtotal - Facilities				**$7,250,000**		**$7,000,000**		**$3,500,000**
A. Construction Subtotal				**$171,121,528**		**$139,155,564**		**$128,641,390**
Environmental Mitigation	Percent of A	2%		$3,422,431		$2,783,111		$2,572,828
B. Construction Cost Subtotal				**$174,543,959**		**$141,938,675**		**$131,214,218**
System Envelope	square foot	$25	1,514,044	$37,851,100	1,071,777	$26,794,425	1,012,180	$25,304,500
New Parking Spaces	square foot	$25	453,024	$11,325,600	348,480	$8,712,000	278,784	$6,969,600
C. Right of Way Subtotal				**$49,176,700**		**$35,506,425**		**$32,274,100**
Revenue Vehicles	Each	$3,000,000	19	$57,000,000	17	$51,000,000	14	$42,000,000
Spare Parts	Percent	10%		$5,700,000		$5,100,000		$4,200,000
MOW Equipment	Rt Mile	$225,000	13	$2,835,000	9	$1,944,000	9	$2,025,000
D. Vehicles Subtotal				**$65,535,000**		**$58,044,000**		**$48,225,000**
Cost Contingencies (Uncertainties, Changes)								
Design&Construction	Percent of B	25%		$43,635,990		$35,484,669		$32,803,554
Right of Way	Percent of C	30%		$14,753,010		$10,651,928		$9,682,230
Vehicle Cost	Percent of D	10%		$6,553,500		$5,804,400		$4,822,500
Program Implementation (Agency Costs and Fees)								
Design&Construction	Percent of B	31%		$54,108,627		$44,000,989		$40,676,408
Right of Way Purchase	Percent of C	15%		$7,376,505		$5,325,964		$4,841,115
Vehicle Procurement	Percent of D	5%		$3,276,750		$2,902,200		$2,411,250
E. Capital Cost Subtotal				**$418,960,040**		**$339,659,250**		**$306,950,375**
Project Reserve	Percent of E	10%		$41,896,004		$33,965,925		$30,695,037.48
F. Total Capital Cost				**$460,856,044**		**$373,625,175**		**$337,645,412**

Note: All costs are in Year 2001 Dollars

Light Rail Transit Estimated Costs
(Ballasted Track)

Item	Units	Avg. Unit Cost	Amount	*Scottsdale/UP Tempe Combo*	Amount	*Glendale Avenue*	Amount	*Camelback Road*	Amount	*Central Avenue South*
Alignment Breakdown										
Surface (Median)	linear ft			96,360		43,560		42,926		20,750
Surface (Rail ROW, Freeway)	linear ft			23,760		-				
Freeway/Bridge Crossings (Locations)	linear ft			3,960		7,920		2,640		5,280
Elevated (Aerial Locations)	linear ft			5,280						
Elevated/Special (Aerial Locations)	linear ft			5,280						
Street Crossings	each			7		-				
Intersections	each			110		48		42		48
Signal Intersections	each			64		29		26		22
Basic intersection traffic mitigation	Each	$53,000		$0		$0		$0		$0
Intersection Modifications (Spot widening)	Each	$320,000		$0		$0		$0		$0
Modify/Move Traffic Signals	Sig. Intrsctn	$65,000	64	$4,160,000	29	$1,885,000	26	$1,690,000	22	$1,430,000
Roadway Widening	linear ft	$275	96,360	$26,499,000	43,560	$11,979,000	42,926	$11,804,650	20,750	$5,706,360
New at-grade crossing (in freight railway)	Each	$265,000	7	$1,855,000	0	$0		$0		$0
Civil/Roadway Modifications (at intersections)	linear ft	$230	11,000	$2,530,000	4,800	$1,104,000	4,200	$966,000	4,800	$1,104,000
Subtotal-Civil Site Mods				**$35,044,000**		**$14,968,000**		**$14,460,650**		**$8,240,360**
Surface Track Embedded in Street	linear ft	$472	11,700	$5,522,400	4,800	$2,265,600	4,200	$1,982,400	4,800	$2,265,600
Surface Track Ballast	linear ft	$159	108,420	$17,238,780	38,760	$6,162,840	38,726	$6,157,434	15,950	$2,536,114
Dual Track Aerial	Aerial Rt Ft	$4,000	14,520	$58,080,000	7,920	$31,680,000	2,640	$10,560,000	5,280	$21,120,000
Long Span Aerial Structures	Aerial Rt Ft	$8,000	0	$0		$0		$0		$0
Subtotal-Guideway				**$80,841,180**		**$40,108,440**		**$18,699,834**		**$25,921,714**
Utility Relocation	Linear ft	$425	134,640	$57,222,000	51,480	$21,879,000	45,566	$19,365,550	26,030	$11,062,920
Subtotal-Utilities				**$57,222,000**		**$21,879,000**		**$19,365,550**		**$11,062,920**
Direct Fixation Track (on structure)	linear ft	$490	14,520	$7,114,800	7,920	$3,880,800	2,640	$1,293,600	5,280	$2,587,200
Ballast Track (at-grade)	linear ft	$345	108,420	$37,404,900	38,760	$13,372,200	38,726	$13,360,470	15,950	$5,502,888
Embedded Track (in pavement)	linear ft	$495	11,700	$5,791,500	4,800	$2,376,000	4,200	$2,079,000	4,800	$2,376,000
Subtotal-Track				**$50,311,200**		**$19,629,000**		**$16,733,070**		**$10,466,088**
Surface Stations	Each	$900,000	22	$19,800,000	8	$7,200,000	7	$6,300,000	5	$4,500,000
Aerial Stations	Each	$3,000,000	0	$0	2	$6,000,000	1	$3,000,000	0	$0
Hub Station (surface)	Each	$1,500,000	3	$4,500,000	0	$0	1	$1,500,000	0	$0
Surface Parking	Space	$3,000	1,875	$5,625,000	750	$2,250,000	675	$2,025,000	375	$1,125,000
Parking Structures	Space	$10,000	1,875	$18,750,000	750	$7,500,000	675	$6,750,000	375	$3,750,000
Elevated Ped Xings	Each	$1,000,000	0	$0	2	$2,000,000	1	$1,000,000	0	$0
Subtotal-Stations				**$48,675,000**		**$24,950,000**		**$20,575,000**		**$9,375,000**
Ticket Vending Machines	Station	$390,000	25	$9,750,000	10	$3,900,000	9	$3,510,000	5	$1,950,000
Substations	Each	$1,150,000	25	$28,750,000	10	$11,500,000	9	$10,350,000	5	$5,750,000
Overhead Catenary	linear ft	$195	134,640	$26,254,800	51,480	$10,038,600	45,566	$8,885,370	26,030	$5,075,928
Catenary Foundations	linear ft	$55	120,120	$6,606,600	43,560	$2,395,800	42,926	$2,360,930	20,750	$1,141,272
Communications/Signals	linear ft	$245	134,640	$32,986,800	51,480	$12,612,600	45,566	$11,163,670	26,030	$6,377,448
Crossover Interlockings	Each	$210,000	13	$2,730,000	5	$1,050,000	4	$840,000	3	$630,000
Duct Bank - Aerial	Aerial Rt Ft	$37	14,520	$537,240	7,920	$293,040	2,640	$97,680	5,280	$195,360
Duct Bank - At Grade	linear ft	$37	120,120	$4,444,440	43,560	$1,611,720	42,926	$1,588,262	20,750	$767,765
Lighting At Grade	Surfc Rt Mile	$375,000	26	$9,562,500	10	$3,656,250	9	$3,236,250	5	$1,848,750
Subtotal-Sys Electrical				**$121,622,380**		**$47,058,010**		**$42,032,162**		**$23,736,523**
Maintenance/Storage	Each			$9,500,000		$4,250,000		$3,500,000		$2,500,000
Operations Control	Each			$2,500,000		$2,000,000		$2,000,000		$2,000,000
Subtotal - Facilities				**$12,000,000**		**$6,250,000**		**$5,500,000**		**$4,500,000**
A. Construction Subtotal				**$405,715,760**		**$174,842,450**		**$137,366,266**		**$93,302,604**
Environmental Mitigation	Percent of A	2%		$8,114,315		$3,496,849		$2,747,325		$1,866,052
B. Construction Cost Subtotal				**$413,830,075**		**$178,339,299**		**$140,113,591**		**$95,168,656**
System Envelope	square foot	$25	2,509,760	$62,744,000	891,480	$22,287,000	890,698	$22,267,450	366,859	$9,171,480
New Parking Spaces	square foot	$25	871,200	$21,780,000	348,480	$8,712,000	313,632	$7,840,800	174,240	$4,356,000
C. Right of Way Subtotal				**$84,524,000**		**$30,999,000**		**$30,108,250**		**$13,527,480**
Revenue Vehicles	Each	$3,000,000	38	$114,000,000	17	$51,000,000	14	$42,000,000	10	$30,000,000
Spare Parts	Percent	10%		$11,400,000		$5,100,000		$4,200,000		$3,000,000
MOW Equipment	Rt Mile	$225,000	26	$5,737,500	10	$2,193,750	9	$1,941,750	5	$1,109,250
D. Vehicles Subtotal				**$131,137,500**		**$58,293,750**		**$48,141,750**		**$34,109,250**
Cost Contingencies (Uncertainties, Changes)										
Design&Construction	Percent of B	25%		$103,457,519		$44,584,825		$35,028,398		$23,792,164
Right of Way	Percent of C	30%		$25,357,200		$9,299,700		$9,032,475		$4,058,244
Vehicle Cost	Percent of D	10%		$13,113,750		$5,829,375		$4,814,175		$3,410,925
Program Implementation (Agency Costs and Fees)										
Design&Construction	Percent of B	31%		$128,287,323		$55,285,183		$43,435,213		$29,502,284
Right of Way Purchase	Percent of C	15%		$12,678,600		$4,649,850		$4,516,238		$2,029,122
Vehicle Procurement	Percent of D	5%		$6,556,875		$2,914,688		$2,407,088		$1,705,463
E. Capital Cost Subtotal				**$918,942,842**		**$390,195,669**		**$317,597,177**		**$207,303,588**
Project Reserve	Percent of E	10%		$91,894,284		$39,019,566.89		$31,759,717.75		$20,730,358.76
F. Total Capital Cost				**$1,010,837,127**		**$429,215,236**		**$349,356,895**		**$228,033,946**

Note: All costs are in Year 2001 Dollars

59th Avenue

LRT - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak
Travel/Track Miles of Line	18.99	18.99	For branches, miles = travel	headway
Stations:			distance; not additive	15
* Surface	see total -------------	18		on each line
* Aerial	see total -------------	1		
Operating Times:				
* 1-way run, minutes	*51.8*		Baseline to Bell, average NB/SB	
Round trip w/o recovery (min)	104		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**115**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	8	8	combined - 15' peak headways (H)	
LRTs (Basic 2-car consist)	16	16		
* Cars in service (peak)	16	16		
* Fleet		19	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	104	104	7 hr @ 15' H, 12 hr @ 30' H	
* Car Hrs per day:				
- Base	104	104	Single cars, 19 hrs/day	
- Peak	104	104	*2nd car, 19 hrs/day*	
- Total	208	208		
* *Schedule* speed, mph	19.8		Includes dwell and recovery times	
* Car miles per day	4,118	4,118		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	62,400	62,400		
- Car Miles	1,235,400	1,235,400		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 4.2	$ millions	
* Rev Veh Mi @ $2.09		$ 2.6	$ millions	
* Peak Veh @ $147000		$ 2.4	$ millions	
* Line Mi @ $82000		$ 1.6	$ millions	
* Pass Stations @ $26000		$ 0.49	$ millions	
*** Total Annual O&M**		**$11.29**	$ millions	

Bell Road

LRT - Fleet Sizing and O&M Estimate

Item			**Comments**
Travel/Track Miles of Line	28.55	28.55	peak headway **10** on each line
Stations:			
* Surface	see total -------------	27	
* Aerial	see total -------------	2	
Operating Times:			
* 1-way run, minutes	*77.9*		Scottsdale to Loop 303, average WB/EB
Round trip w/o recovery (min)	156		excluding turn-around time at ends of line
* 2-way cycle, minutes	**170**		average cycle
Vehicle Fleet:			
* Trains in service (peak)	17	17	combined - 10' peak headways (H)
LRTs (Basic 2-car consist)	34	34	
* Cars in service (peak)	34	34	
* Fleet		41	In service + 20% spares
Train & Car Hrs & Miles:			
* Train Hours:			
- Daily	221	221	7 hr @ 10' H, 12 hr @ 20' H
* Car Hrs per day:			
- Base	221	221	Single cars, 19 hrs/day
- Peak	221	221	*2nd car, 19 hrs/day*
- Total	442	442	
* *Schedule* speed, mph	20.2		Includes dwell and recovery times
* Car miles per day	8,928	8,928	
* Annualization:			300 equivalent weekdays/year
- Car Hours	132,600	132,600	
- Car Miles	2,678,400	2,678,400	
O&M Cost Estimates:			
* Rev. Veh Hrs @ $67		$ 8.9	$ millions
* Rev Veh Mi @ $2.09		$ 5.6	$ millions
* Peak Veh @ $147000		$ 5.0	$ millions
* Line Mi @ $82000		$ 2.3	$ millions
* Pass Stations @ $26000		$ 0.75	$ millions
* **Total Annual O&M**		**$22.55**	$ millions

Camelback Road
LRT - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak
Travel/Track Miles of Line	8.63	8.63	For branches, miles = travel	headway
Stations:			distance; not additive	**10**
* Surface	see total -------------	8		on each line
* Aerial	see total -------------	1		
Operating Times:				
* 1-way run, minutes	*23.5*		Scottsdale to Loop 101, average WB/EB	
Round trip w/o recovery (min)	47		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**57**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	6	6	combined - 10' peak headways (H)	
LRTs (Basic 2-car consist)	12	12		
* Cars in service (peak)	12	12		
* Fleet		14	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	78	78	7 hr @ 10' H, 12 hr @ 20' H	
* Car Hrs per day:				
- Base	78	78	Single cars, 19 hrs/day	
- Peak	78	78	*2nd car, 19 hrs/day*	
- Total	156	156		
* *Schedule* speed, mph	18.1		Includes dwell and recovery times	
* Car miles per day	2,824	2,824		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	46,800	46,800		
- Car Miles	847,200	847,200		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 3.1	$ millions	
* Rev Veh Mi @ $2.09		$ 1.8	$ millions	
* Peak Veh @ $147000		$ 1.8	$ millions	
* Line Mi @ $82000		$ 0.7	$ millions	
* Pass Stations @ $26000		$ 0.23	$ millions	
*** Total Annual O&M**		**$7.63**	$ millions	

Central Avenue South
LRT - Fleet Sizing and O&M Estimate

Item			Comments	
				peak headway
Travel/Track Miles of Line	4.93	4.93	For branches, miles = travel distance; not additive	10
Stations:				on each line
* Surface	see total -------------	5		
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*13.4*		Jefferson Street to Baseline Road, average NB/SB	
Round trip w/o recovery (min)	27		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**37**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	4	4	combined - 10' peak headways (H)	
LRTs (Basic 2-car consist)	8	8		
* Cars in service (peak)	8	8		
* Fleet		10	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	52	52	7 hr @ 10' H, 12 hr @ 20' H	
* Car Hrs per day:				
- Base	52	52	Single cars, 19 hrs/day	
- Peak	52	52	*2nd car, 19 hrs/day*	
- Crush	0	-	***3rd car, trains, 7hrs/day***	
- Total	104	104		
* *Schedule* speed, mph	16		Includes dwell and recovery times	
* Car miles per day	1,664	1,664		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	31,200	31,200		
- Car Miles	499,200	499,200		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 2.1	$ millions	
* Rev Veh Mi @ $2.09		$ 1.0	$ millions	
* Peak Veh @ $147000		$ 1.2	$ millions	
* Line Mi @ $82000		$ 0.4	$ millions	
* Pass Stations @ $26000		$ 0.13	$ millions	
*** Total Annual O&M**		**$4.83**	$ millions	

Chandler Boulevard
LRT - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak
Travel/Track Miles of Line	16.45	16.45	For branches, miles = travel	headway
Stations:			distance; not additive	15
* Surface	see total -------------	14		on each line
* Aerial	see total -------------	3		
Operating Times:				
* 1-way run, minutes	*44.9*		Ray Road to Power Road, average WB/EB	
Round trip w/o recovery (min)	90		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**100**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	7	7	combined - 15' peak headways (H)	
LRTs (Basic 2-car consist)	14	14		
* Cars in service (peak)	14	14		
* Fleet		17	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	91	91	7 hr @ 15' H, 12 hr @ 30' H	
* Car Hrs per day:				
- Base	91	91	Single cars, 19 hrs/day	
- Peak	91	91	*2nd car, 19 hrs/day*	
- Total	182	182		
* *Schedule* speed, mph	19.7		Includes dwell and recovery times	
* Car miles per day	3,585	3,585		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	54,600	54,600		
- Car Miles	1,075,500	1,075,500		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 3.7	$ millions	
* Rev Veh Mi @ $2.09		$ 2.2	$ millions	
* Peak Veh @ $147000		$ 2.1	$ millions	
* Line Mi @ $82000		$ 1.3	$ millions	
* Pass Stations @ $26000		$ 0.44	$ millions	
*** Total Annual O&M**		**$9.74**	$ millions	

Glendale Avenue

LRT - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak
Travel/Track Miles of Line	9.75	9.75	For branches, miles = travel	headway
Stations:			distance; not additive	**10**
* Surface	see total -------------	8		on each line
* Aerial	see total -------------	2		
Operating Times:				
* 1-way run, minutes	*26.6*		19th to Grand School, average WB/EB	
Round trip w/o recovery (min)	53		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**63**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	7	7	combined - 10' peak headways (H)	
LRTs (Basic 2-car consist)	14	14		
* Cars in service (peak)	14	14		
* Fleet		17	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	91	91	7 hr @ 10' H, 12 hr @ 20' H	
* Car Hrs per day:				
- Base	91	91	Single cars, 19 hrs/day	
- Peak	91	91	*2nd car, 19 hrs/day*	
- Total	182	182		
* *Schedule* speed, mph	18.5		Includes dwell and recovery times	
* Car miles per day	3,367	3,367		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	54,600	54,600		
- Car Miles	1,010,100	1,010,100		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 3.7	$ millions	
* Rev Veh Mi @ $2.09		$ 2.1	$ millions	
* Peak Veh @ $147000		$ 2.1	$ millions	
* Line Mi @ $82000		$ 0.8	$ millions	
* Pass Stations @ $26000		$ 0.26	$ millions	
*** Total Annual O&M**		**$8.96**	$ millions	

I-10 West

LRT - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak headway
Travel/Track Miles of Line	11.05	11.05	For branches, miles = travel distance; not additive	10
Stations:				
* Surface	see total -------------	11		on each line
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*30.1*		Central to Loop 101 W, average WB/EB	
Round trip w/o recovery (min)	60		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**70**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	8	8	combined - 10' peak headways (H)	
LRTs (Basic 2-car consist)	16	16		
* Cars in service (peak)	16	16		
* Fleet		19	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	104	104	7 hr @ 10' H, 12 hr @ 20' H	
* Car Hrs per day:				
- Base	104	104	Single cars, 19 hrs/day	
- Peak	104	104	*2nd car, 19 hrs/day*	
- Total	208	208		
* *Schedule* speed, mph	18.9		Includes dwell and recovery times	
* Car miles per day	3,931	3,931		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	62,400	62,400		
- Car Miles	1,179,300	1,179,300		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 4.2	$ millions	
* Rev Veh Mi @ $2.09		$ 2.5	$ millions	
* Peak Veh @ $147000		$ 2.4	$ millions	
* Line Mi @ $82000		$ 0.9	$ millions	
* Pass Stations @ $26000		$ 0.29	$ millions	
*** Total Annual O&M**		**$10.29**	$ millions	

Main Street
LRT - Fleet Sizing and O&M Estimate

Item			Comments	
				peak headway
Travel/Track Miles of Line	9.64	9.64	For branches, miles = travel distance; not additive	10
Stations:				on each line
* Surface	see total -------------	10		
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*26.3*		Alma School to Power, average WB/EB	
Round trip w/o recovery (min)	53		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**63**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	7	7	combined - 10' peak headways (H)	
LRTs (Basic 2-car consist)	14	14		
* Cars in service (peak)	14	14		
* Fleet		17	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	91	91	7 hr @ 10' H, 12 hr @ 20' H	
* Car Hrs per day:				
- Base	91	91	Single cars, 19 hrs/day	
- Peak	91	91	*2nd car, 19 hrs/day*	
- Total	182	182		
* *Schedule* speed, mph	18.5		Includes dwell and recovery times	
* Car miles per day	3,367	3,367		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	54,600	54,600		
- Car Miles	1,010,100	1,010,100		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 3.7	$ millions	
* Rev Veh Mi @ $2.09		$ 2.1	$ millions	
* Peak Veh @ $147000		$ 2.1	$ millions	
* Line Mi @ $82000		$ 0.8	$ millions	
* Pass Stas @ $26000		$ 0.26	$ millions	
*** Total Annual O&M**		**$8.96**	$ millions	

Metrocenter/I-17
LRT - Fleet Sizing and O&M Estimate

Item			Comments		
				peak	
Travel/Track Miles of Line	8.75	8.75	For branches, miles = travel	headway	
Stations:			distance; not additive	**10**	
* Surface	see total -------------	7		on each line	
* Aerial	see total -------------	1			
Operating Times:					
* 1-way run, minutes	*23.9*		19th/Bethany Home to Bell Road, average NB/SB		
Round trip w/o recovery (min)	48		excluding turn-around time at ends of line		
* 2-way cycle, minutes	**58**		average cycle		
Vehicle Fleet:					
* Trains in service (peak)	6	6	combined - 10' peak headways (H)		
LRTs (Basic 2-car consist)	12	12			
* Cars in service (peak)	12	12			
* Fleet		14	In service + 20% spares		
Train & Car Hrs & Miles:					
* Train Hours:					
- Daily	78	78	7 hr @ 10' H, 12 hr @ 20' H		
* Car Hrs per day:					
- Base	78	78	Single cars, 19 hrs/day		
- Peak	78	78	*2nd car, 19 hrs/day*		
- Total	156	156			
* *Schedule* speed, mph	18.2		Includes dwell and recovery times		
* Car miles per day	2,839	2,839			
* Annualization:			300 equivalent weekdays/year		
- Car Hours	46,800	46,800			
- Car Miles	851,700	851,700			
O&M Cost Estimates:					
* Rev. Veh Hrs @ $67		$ 3.1	$ millions		
* Rev Veh Mi @ $2.09		$ 1.8	$ millions		
* Peak Veh @ $147000		$ 1.8	$ millions		
* Line Mi @ $82000		$ 0.7	$ millions		
* Pass Stations @ $26000		$ 0.21	$ millions		
*** Total Annual O&M**		**$7.61**	$ millions		

Power Road
LRT - Fleet Sizing and O&M Estimate

Item			Comments
			peak headway 15 on each line
Travel/Track Miles of Line	13.04	13.04	For branches, miles = travel distance; not additive
Stations:			
* Surface	see total -------------	13	
* Aerial	see total -------------	1	
Operating Times:			
* 1-way run, minutes	*35.6*		Williams Field to McDowell/Higley, average NB/SB
Round trip w/o recovery (min)	71		excluding turn-around time at ends of line
* 2-way cycle, minutes	**81**		average cycle
Vehicle Fleet:			
* Trains in service (peak)	6	6	combined - 15' peak headways (H)
LRTs (Basic 2-car consist)	12	12	
* Cars in service (peak)	12	12	
* Fleet		14	In service + 20% spares
Train & Car Hrs & Miles:			
* Train Hours:			
- Daily	78	78	7 hr @ 15' H, 12 hr @ 30' H
* Car Hrs per day:			
- Base	78	78	Single cars, 19 hrs/day
- Peak	78	78	*2nd car, 19 hrs/day*
- Total	156	156	
* *Schedule* speed, mph	19.3		Includes dwell and recovery times
* Car miles per day	3,011	3,011	
* Annualization:			300 equivalent weekdays/year
- Car Hours	46,800	46,800	
- Car Miles	903,300	903,300	
O&M Cost Estimates:			
* Rev. Veh Hrs @ $67		$ 3.1	$ millions
* Rev Veh Mi @ $2.09		$ 1.9	$ millions
* Peak Veh @ $147000		$ 1.8	$ millions
* Line Mi @ $82000		$ 1.1	$ millions
* Pass Stations @ $26000		$ 0.36	$ millions
*** Total Annual O&M**		**$8.26**	$ millions

Scottsdale Road/UP Tempe Branch
LRT - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak
Travel/Track Miles of Line	25.50	25.50	For branches, miles = travel	headway
Stations:			distance; not additive	**10**
* Surface	see total -------------	25		on each line
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*69.5*		Price/Queen Creek to Bell, average NB/SB	
Round trip w/o recovery (min)	139		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**155**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	16	16	combined - 10' peak headways (H)	
LRTs (Basic 2-car consist)	32	32		
* Cars in service (peak)	32	32		
* Fleet		38	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	208	208	7 hr @ 10' H, 12 hr @ 20' H	
* Car Hrs per day:				
- Base	208	208	Single cars, 19 hrs/day	
- Peak	208	208	*2nd car, 19 hrs/day*	
- Crush	0	-	***3rd car, trains, 7hrs/day***	
- Total	416	416		
* *Schedule* speed, mph	19.7		Includes dwell and recovery times	
* Car miles per day	8,195	8,195		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	124,800	124,800		
- Car Miles	2,458,500	2,458,500		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 8.4	$ millions	
* Rev Veh Mi @ $2.09		$ 5.1	$ millions	
* Peak Veh @ $147000		$ 4.7	$ millions	
* Line Mi @ $82000		$ 2.1	$ millions	
* Pass Stations @ $26000		$ 0.65	$ millions	
*** Total Annual O&M**		**$20.95**	$ millions	

SR-51

LRT - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak
Travel/Track Miles of Line	17.34	17.34	For branches, miles = travel	headway
Stations:			distance; not additive	**10**
* Surface	see total -------------	13		on each line
* Aerial	see total -------------	4		
Operating Times:				
* 1-way run, minutes	*47.3*		Glendale 19th to Mayo Clinic, average NB/SB	
Round trip w/o recovery (min)	95		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**105**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	11	11	combined - 10' peak headways (H)	
LRTs (Basic 2-car consist)	22	22		
* Cars in service (peak)	22	22		
* Fleet		26	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	143	143	7 hr @ 10' H, 12 hr @ 20' H	
* Car Hrs per day:				
- Base	143	143	Single cars, 19 hrs/day	
- Peak	143	143	*2nd car, 19 hrs/day*	
- Total	286	286		
* *Schedule* speed, mph	19.8		Includes dwell and recovery times	
* Car miles per day	5,663	5,663		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	85,800	85,800		
- Car Miles	1,698,900	1,698,900		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 5.7	$ millions	
* Rev Veh Mi @ $2.09		$ 3.6	$ millions	
* Peak Veh @ $147000		$ 3.2	$ millions	
* Line Mi @ $82000		$ 1.4	$ millions	
* Pass Stations @ $26000		$ 0.44	$ millions	
*** Total Annual O&M**		**$14.34**	$ millions	

Union Pacific Chandler Branch

LRT - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak headway
Travel/Track Miles of Line	12.60	12.60	For branches, miles = travel distance; not additive	10
Stations:				
* Surface	see total -------------	13		on each line
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*34.4*		Price to Baseline, average NB/SB	
Round trip w/o recovery (min)	69		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**79**		average cycle	
Vehicle Fleet:				
* Trains in service (peak)	8	8	combined - 10' peak headways (H)	
LRTs (Basic 2-car consist)	16	16		
* Cars in service (peak)	16	16		
* Fleet		19	In service + 20% spares	
Train & Car Hrs & Miles:				
* Train Hours:				
- Daily	104	104	7 hr @ 10' H, 12 hr @ 20' H	
* Car Hrs per day:				
- Base	104	104	Single cars, 19 hrs/day	
- Peak	104	104	*2nd car, 19 hrs/day*	
- Total	208	208		
* *Schedule* speed, mph	19.2		Includes dwell and recovery times	
* Car miles per day	3,994	3,994		
* Annualization:			300 equivalent weekdays/year	
- Car Hours	62,400	62,400		
- Car Miles	1,198,200	1,198,200		
O&M Cost Estimates:				
* Rev. Veh Hrs @ $67		$ 4.2	$ millions	
* Rev Veh Mi @ $2.09		$ 2.5	$ millions	
* Peak Veh @ $147000		$ 2.4	$ millions	
* Line Mi @ $82000		$ 1.0	$ millions	
* Pass Stations @ $26000		$ 0.34	$ millions	
*** Total Annual O&M**		**$10.44**	$ millions	

Appendix C

Dedicated BRT Estimated Capital Costs

Item	Units	Avg. Unit Cost	Amount	Bell Road	Amount	Camelback Road	Amount	Chandler Boulevard
Alignment Breakdown								
Surface (Median)	linear ft			150,769		45,566		86,876
Intersections	each			100		42		68
Signal Intersections	each			69		26		45
In Freeway								
Freeway Crossings								
Elevated	Aerial Rt Ft							
New Concrete Sidewalk/Curb/Gutter	linear ft	$27.46	140,769	$3,865,517	41,366	$1,135,910	80,076	$2,198,887
Construct AC Pavement & Base (new Roadway)	linear ft	$66.61	150,769	$10,042,723	45,566	$3,035,151	86,876	$5,786,810
Median Curb	linear ft	$8.13	140,769	$1,144,452	45,624	$370,923	80,076	$651,018
Reconstruct Intersection	each	$50,000	100	$5,000,000	42	$2,100,000	68	$3,400,000
Remove Existing Pavement/Curb/Gutter	linear ft	$12.54	150,769	$1,890,643	45,566	$571,398	86,876	$1,089,425
Roadway Excavation	Cubic Yard	$18.35	452,307	$8,299,833	136,698	$2,508,408	260,628	$4,782,524
Construct Concrete & Base (new Bus lanes)	linear ft	$184	150,769	$27,741,496	45,566	$8,384,144	86,876	$15,985,184
Signing/Striping	Percent of Above	5%		$2,899,233		$905,297		$1,694,692
Subtotal-Civil/Roadway				**$60,883,898**		**$19,011,231**		**$35,588,540**
Utility Relocation	linear ft	$350	150,769	$52,769,150	45,566	$15,948,100	86,876	$30,406,600
Subtotal-Utilities				**$52,769,150**		**$15,948,100**		**$30,406,600**
Surface Stations	Each	$700,000	29	$20,300,000	9	$6,300,000	17	$11,900,000
Surface Parking	Space	$2,800	2,175	$6,090,000	675	$1,890,000	1,275	$3,570,000
Parking Structures	Space	$9,500	2,175	$20,662,500	675	$6,412,500	1,275	$12,112,500
Elevated Ped Xings	Each	$1,000,000		$0		$0		$0
Subtotal-Stations				**$47,052,500**		**$14,602,500**		**$27,582,500**
Ticket Vending Machines	Each Station	$370,000	29	$10,730,000	9	$3,330,000	17	$6,290,000
On-Board AVL Equipment	Each Vehicle	$22,000	46	$1,012,000	14	$308,000	19	$418,000
On-Board Signal Priority System	Each Vehicle	$9,000	46	$414,000	14	$126,000	19	$171,000
Traffic Signal Priority and Intersections	Each	$20,000	69	$1,380,000	26	$520,000	45	$900,000
Signals and Communication	Station	$77,000	29	$2,233,000	9	$693,000	17	$1,309,000
Lighting At Grade	mile	$375,000	29	$10,708,026	9	$3,236,222	16	$6,170,170
Subtotal-Sys El				**$26,477,026**		**$8,213,222**		**$15,258,170**
Maintenance/Storage	Each			$6,900,000		$2,100,000		$2,850,000
AVL Equipment	Lump			$800,000		$800,000		$800,000
Operations Control	Each			$250,000		$250,000		$250,000
Subtotal Facilities				**$7,950,000**		**$3,150,000**		**$3,900,000**
A. Construction Subtotal				**$195,132,573**		**$60,925,053**		**$112,735,811**
Environmental Mitigation	Percent of A	2%		$3,902,651		$1,218,501		$2,254,716
B. Construction Cost Subtotal				**$199,035,225**		**$62,143,554**		**$114,990,527**
System Envelope	square foot	$25	3,237,687	$80,942,175	951,418	$23,785,450	1,841,748	$46,043,700
New Parking Spaces	square foot	$25	1,010,592	$25,264,800	313,632	$7,840,800	592,416	$14,810,400
C. Right of Way Subtotal				**$106,206,975**		**$31,626,250**		**$60,854,100**
Revenue Vehicles (40' Diesel Bus)	Each	$275,000	0	$0		$0		$0
Revenue Vehicles (40' CNG Bus)	Each	$360,000	0	$0	0	$0	0	$0
Revenue Vehicles (60' Articulated Bus)	Each	$440,000	46	$20,240,000	14	$6,160,000	19	$8,360,000
Spare Parts	Percent	10%		$2,024,000		$616,000		$836,000
D. Vehicles Subtotal				**$22,264,000**		**$6,776,000**		**$9,196,000**
Cost Contingencies (Uncertainties, Changes)								
Design&Construction	Percent of B	25%		$49,758,806		$15,535,889		$28,747,632
Right of Way	Percent of C	30%		$31,862,093		$9,487,875		$18,256,230
Vehicle Cost	Percent of D	10%		$2,226,400		$677,600		$919,600
Program Implementation (Agency Costs and Fees)								
Design&Construction	Percent of B	31%		$61,700,920		$19,264,502		$35,647,063
Right of Way Purchase	Percent of C	15%		$15,931,046		$4,743,938		$9,128,115
Vehicle Procurement	Percent of D	5%		$1,113,200		$338,800		$459,800
E. Capital Cost Subtotal				**$490,098,664**		**$150,594,407**		**$278,199,067**
Project Reserve	Percent of E	10%		$49,009,866		$15,059,441		$27,819,907
F. Total Capital Cost				**$539,108,531**		**$165,653,848**		**$306,018,974**

Note: All costs are in Year 2001 Dollars

Dedicated BRT Estimated Capital Costs

Item	Units	Avg. Unit Cost	Amount	Scottsdale Road	Amount	Power Road	Amount	SR-51
Alignment Breakdown								
Surface (Median)	linear ft			134,640		68,864		61,195
Intersections	each			117		45		37
Signal Intersections	each			71		35		24
In Freeway								30,360
Freeway Crossings								
Elevated	Aerial Rt Ft							
New Concrete Sidewalk/Curb/Gutter	linear ft	$27.46	85,360	$2,343,986	64,364	$1,767,435	57,495	$1,578,813
Construct AC Pavement & Base (new Roadway)	linear ft	$66.61	96,360	$6,418,540	68,864	$4,587,031	61,195	$4,076,199
Median Curb	linear ft	$8.13	122,940	$999,502	64,364	$523,279	57,495	$467,434
Reconstruct Intersection	each	$50,000	117	$5,850,000	45	$2,250,000	37	$1,850,000
Remove Existing Pavement/Curb/Gutter	linear ft	$12.54	97,060	$1,217,132	68,864	$863,555	61,195	$767,385
Roadway Excavation	Cubic Yard	$18.35	291,180	$5,343,153	206,592	$3,790,963	183,585	$3,368,785
Construct Concrete & Base (new Bus lanes)	linear ft	$184	134,640	$24,773,760	68,864	$12,670,976	61,195	$11,259,880
Signing/Striping	Percent of Above	5%		$2,347,304		$1,322,662		$1,168,425
Subtotal-Civil/Roadway				**$49,293,376**		**$27,775,902**		**$24,536,921**
Utility Relocation	linear ft	$350	134,640	$47,124,000	68,864	$24,102,400	61,195	$21,418,250
Subtotal-Utilities				**$47,124,000**		**$24,102,400**		**$21,418,250**
Surface Stations	Each	$700,000	25	$17,500,000	13	$9,100,000	17	$11,900,000
Surface Parking	Space	$2,800	1,875	$5,250,000	975	$2,730,000	1,275	$3,570,000
Parking Structures	Space	$9,500	1,875	$17,812,500	975	$9,262,500	1,275	$12,112,500
Elevated Ped Xings	Each	$1,000,000		$0		$0		$0
Subtotal-Stations				**$40,562,500**		**$21,092,500**		**$27,582,500**
Ticket Vending Machines	Each Station	$370,000	25	$9,250,000	13	$4,810,000	17	$6,290,000
On-Board AVL Equipment	Each Vehicle	$22,000	41	$902,000	11	$242,000	28	$616,000
On-Board Signal Priority System	Each Vehicle	$9,000	41	$369,000	11	$99,000	28	$252,000
Traffic Signal Priority and Intersections	Each	$20,000	71	$1,420,000	35	$700,000	24	$480,000
Signals and Communication	Station	$77,000	25	$1,925,000	13	$1,001,000	17	$1,309,000
Lighting At Grade	mile	$375,000	26	$9,562,500	13	$4,890,909	12	$4,346,236
Subtotal-Sys El				**$23,428,500**		**$11,742,909**		**$13,293,236**
Maintenance/Storage	Each			$6,150,000		$1,650,000		$4,200,000
AVL Equipment	Lump			$800,000		$800,000		$800,000
Operations Control	Each			$250,000		$250,000		$250,000
Subtotal Facilities				**$7,200,000**		**$2,700,000**		**$5,250,000**
A. Construction Subtotal				**$167,608,376**		**$87,413,711**		**$92,080,907**
Environmental Mitigation	Percent of A	2%		$3,352,168		$1,748,274		$1,841,618
B. Construction Cost Subtotal				**$170,960,544**		**$89,161,985**		**$93,922,525**
System Envelope	square foot	$25	2,827,620	$70,690,500	1,480,372	$37,009,300	1,322,385	$33,059,625
New Parking Spaces	square foot	$25	871,200	$21,780,000	453,024	$11,325,600	592,416	$14,810,400
C. Right of Way Subtotal				**$92,470,500**		**$48,334,900**		**$47,870,025**
Revenue Vehicles (40' Diesel Bus)	Each	$275,000		$0		$0		$0
Revenue Vehicles (40' CNG Bus)	Each	$360,000	0	$0	0	$0	0	$0
Revenue Vehicles (60' Articulated Bus)	Each	$440,000	41	$18,040,000	11	$4,840,000	28	$12,320,000
Spare Parts	Percent	10%		$1,804,000		$484,000		$1,232,000
D. Vehicles Subtotal				**$19,844,000**		**$5,324,000**		**$13,552,000**
Cost Contingencies (Uncertainties, Changes)								
Design&Construction	Percent of B	25%		$42,740,136		$22,290,496		$23,480,631
Right of Way	Percent of C	30%		$27,741,150		$14,500,470		$14,361,008
Vehicle Cost	Percent of D	10%		$1,984,400		$532,400		$1,355,200
Program Implementation (Agency Costs and Fees)								
Design&Construction	Percent of B	31%		$52,997,769		$27,640,215		$29,115,983
Right of Way Purchase	Percent of C	15%		$13,870,575		$7,250,235		$7,180,504
Vehicle Procurement	Percent of D	5%		$992,200		$266,200		$677,600
E. Capital Cost Subtotal				**$423,601,274**		**$215,300,901**		**$231,515,475**
Project Reserve	Percent of E	10%		$42,360,127		$21,530,090		$23,151,547
F. Total Capital Cost				**$465,961,401**		**$236,830,991**		**$254,667,022**

Note: All costs are in Year 2001 Dollars

Dedicated BRT Estimated Capital Costs

Item	Units	Avg. Unit Cost	Amount	Union Pacific Chandler Branch	Amount	Main	Amount	59th Avenue
Alignment Breakdown								
Surface (Median)	linear ft			66,528		50,899		100,289
Intersections	each			31		43		106
Signal Intersections	each			30		25		54
In Freeway								
Freeway Crossings								
Elevated	Aerial Rt Ft							
New Concrete Sidewalk/Curb/Gutter	linear ft	$27.46	63,428	$1,741,733	46,599	$1,279,609	89,689	$2,462,860
Construct AC Pavement & Base (new Roadway)	linear ft	$66.61	18,240	$1,214,966	50,899	$3,390,382	100,289	$6,680,250
Median Curb	linear ft	$8.13	63,428	$515,670	46,599	$378,850	89,689	$729,172
Reconstruct Intersection	each	$50,000	7	$350,000	43	$2,150,000	106	$5,300,000
Remove Existing Pavement/Curb/Gutter	linear ft	$12.54	20,740	$260,080	50,899	$638,273	100,289	$1,257,624
Roadway Excavation	Cubic Yard	$18.35	62,220	$1,141,737	152,697	$2,801,990	300,867	$5,520,909
Construct Concrete & Base (new Bus lanes)	linear ft	$184	66,528	$12,241,152	50,899	$9,365,416	100,289	$18,453,176
Signing/Striping	Percent of Above	5%		$873,267		$1,000,226		$2,020,200
Subtotal-Civil/Roadway				**$18,338,604**		**$21,004,746**		**$42,424,191**
Utility Relocation	linear ft	$350	66,528	$23,284,800	50,899	$17,814,650	100,289	$35,101,150
Subtotal-Utilities				**$23,284,800**		**$17,814,650**		**$35,101,150**
Surface Stations	Each	$700,000	13	$9,100,000	10	$7,000,000	19	$13,300,000
Surface Parking	Space	$2,800	975	$2,730,000	750	$2,100,000	1,425	$3,990,000
Parking Structures	Space	$9,500	975	$9,262,500	750	$7,125,000	1,425	$13,537,500
Elevated Ped Xings	Each	$1,000,000		$0		$0		$0
Subtotal-Stations				**$21,092,500**		**$16,225,000**		**$30,827,500**
Ticket Vending Machines	Each Station	$370,000	13	$4,810,000	10	$3,700,000	19	$7,030,000
On-Board AVL Equipment	Each Vehicle	$22,000	20	$440,000	16	$352,000	30	$660,000
On-Board Signal Priority System	Each Vehicle	$9,000	20	$180,000	16	$144,000	30	$270,000
Traffic Signal Priority and Intersections	Each	$20,000	30	$600,000	25	$500,000	54	$1,080,000
Signals and Communication	Station	$77,000	13	$1,001,000	10	$770,000	19	$1,463,000
Lighting At Grade	mile	$375,000	13	$4,725,000	10	$3,614,986	19	$7,122,798
Subtotal-Sys El				**$11,756,000**		**$9,080,986**		**$17,625,798**
Maintenance/Storage	Each			$3,000,000		$2,400,000		$4,500,000
AVL Equipment	Lump			$800,000		$800,000		$1,600,000
Operations Control	Each			$250,000		$250,000		$500,000
Subtotal Facilities				**$4,050,000**		**$3,450,000**		**$6,600,000**
A. Construction Subtotal				**$78,521,904**		**$67,575,382**		**$132,578,639**
Environmental Mitigation	Percent of A	2%		$1,570,438		$1,351,508		$2,651,573
B. Construction Cost Subtotal				**$80,092,342**		**$68,926,890**		**$135,230,212**
System Envelope	square foot	$25	1,458,844	$36,471,100	1,071,777	$26,794,425	2,062,847	$51,571,175
New Parking Spaces	square foot	$25	453,024	$11,325,600	348,480	$8,712,000	662,112	$16,552,800
C. Right of Way Subtotal				**$47,796,700**		**$35,506,425**		**$68,123,975**
Revenue Vehicles (40' Diesel Bus)	Each	$275,000		$0		$0		$0
Revenue Vehicles (40' CNG Bus)	Each	$360,000	0	$0	0	$0	0	$0
Revenue Vehicles (60' Articulated Bus)	Each	$440,000	20	$8,800,000	16	$7,040,000	30	$13,200,000
Spare Parts	Percent	10%		$880,000		$704,000		$1,320,000
D. Vehicles Subtotal				**$9,680,000**		**$7,744,000**		**$14,520,000**
Cost Contingencies (Uncertainties, Changes)								
Design&Construction	Percent of B	25%		$20,023,086		$17,231,722		$33,807,553
Right of Way	Percent of C	30%		$14,339,010		$10,651,928		$20,437,193
Vehicle Cost	Percent of D	10%		$968,000		$774,400		$1,452,000
Program Implementation (Agency Costs and Fees)								
Design&Construction	Percent of B	31%		$24,828,626		$21,367,336		$41,921,366
Right of Way Purchase	Percent of C	15%		$7,169,505		$5,325,964		$10,218,596
Vehicle Procurement	Percent of D	5%		$484,000		$387,200		$726,000
E. Capital Cost Subtotal				**$205,381,269**		**$167,915,864**		**$326,436,894**
Project Reserve	Percent of E	10%		$20,538,127		$16,791,586		$32,643,689
F. Total Capital Cost				**$225,919,396**		**$184,707,451**		**$359,080,584**

Note: All costs are in Year 2001 Dollars

Dedicated BRT Estimated Capital Costs

Item	Units	Avg. Unit Cost	Amount	Grand Avenue
Alignment Breakdown				
Surface (Median)	linear ft			136,224
Intersections	each			71
Signal Intersections	each			38
In Freeway				
Freeway Crossings				
Elevated	Aerial Rt Ft			
New Concrete Sidewalk/Curb/Gutter	linear ft	$27.46	57,000	$1,565,220
Construct AC Pavement & Base (new Roadway)	linear ft	$66.61	0	$0
Median Curb	linear ft	$8.13	0	$0
Reconstruct Intersection	each	$50,000	38	$1,900,000
Remove Existing Pavement/Curb/Gutter	linear ft	$12.54	57,000	$714,780
Roadway Excavation	Cubic Yard	$18.35	171,000	$3,137,850
Construct Concrete & Base (new Bus lanes)	linear ft	$184	57,000	$10,488,000
Signing/Striping	Percent of Above	5%		$890,293
Subtotal-Civil/Roadway				**$18,696,143**
Utility Relocation	linear ft	$350	57,000	$19,950,000
Subtotal-Utilities				**$19,950,000**
Surface Stations	Each	$700,000	13	$9,100,000
Surface Parking	Space	$2,800	975	$2,730,000
Parking Structures	Space	$9,500	975	$9,262,500
Elevated Ped Xings	Each	$1,000,000		$0
Subtotal-Stations				**$21,092,500**
Ticket Vending Machines	Each Station	$370,000	13	$4,810,000
On-Board AVL Equipment	Each Vehicle	$22,000	53	$1,166,000
On-Board Signal Priority System	Each Vehicle	$9,000	53	$477,000
Traffic Signal Priority and Intersections	Each	$20,000	38	$760,000
Signals and Communication	Station	$77,000	13	$1,001,000
Lighting At Grade	mile	$375,000	26	$9,817,500
Subtotal-Sys El				**$18,031,500**
Maintenance/Storage	Each			$7,950,000
AVL Equipment	Lump			$1,200,000
Operations Control	Each			$500,000
Subtotal Facilities				**$9,650,000**
A. Construction Subtotal				**$87,420,143**
Environmental Mitigation	Percent of A	2%		$1,748,403
B. Construction Cost Subtotal				**$89,168,545**
System Envelope	square foot	$25	874,000	$21,850,000
New Parking Spaces	square foot	$25	453,024	$11,325,600
C. Right of Way Subtotal				**$33,175,600**
Revenue Vehicles (40' Diesel Bus)	Each	$275,000		$0
Revenue Vehicles (40' CNG Bus)	Each	$360,000	53	$19,080,000
Revenue Vehicles (60' Articulated Bus)	Each	$440,000	0	$0
Spare Parts	Percent	10%		$1,908,000
D. Vehicles Subtotal				**$20,988,000**
Cost Contingencies (Uncertainties, Changes)				
Design&Construction	Percent of B	25%		$22,292,136
Right of Way	Percent of C	30%		$9,952,680
Vehicle Cost	Percent of D	10%		$2,098,800
Program Implementation (Agency Costs and Fees)				
Design&Construction	Percent of B	31%		$27,642,249
Right of Way Purchase	Percent of C	15%		$4,976,340
Vehicle Procurement	Percent of D	5%		$1,049,400
E. Capital Cost Subtotal				**$211,343,751**
Project Reserve	Percent of E	10%		$21,134,375
F. Total Capital Cost				**$232,478,126**

Note: All costs are in Year 2001 Dollars

59th Avenue
BRT - Fleet Sizing and O&M Estimate

Item			Comments
			peak headway 5 on each line
Travel/Miles of Line	18.99	18.99	
Stations:			
* Surface	see total -------------	27	
* Aerial	see total -------------	-	
Operating Times:			
* 1-way run, minutes	*51.8*		51st Ave/Baseline to Bell, average NB/SB
Round trip w/o recovery (min)	104		excluding turn-around time at ends of line
* 2-way cycle, minutes	**124**		average cycle
Vehicle Fleet:			
* Buses in service (peak)	25	25	combined - 5' peak headways (H)
* Buses in service (off-peak)			
* Fleet		30	In service + 20% spares
Bus Hrs & Miles:			
* Bus Hours:			
- Daily	325	325	7 hr @ 5' H, 12 hr @ 10' H
* Bus Hrs per day:			
- Base	325	325	Single vehicle, 19 hrs/day
- Peak	0	-	
- Crush	-	-	
- Total	325	325	
* *Schedule* speed, mph	18.3		Includes dwell and recovery times
* Bus miles per day	5,948	5,948	
* Annualization:			300 equivalent weekdays/year
- Bus Hours	97,500	97,500	
- Bus Miles	1,784,400	1,784,400	
O&M Cost Estimates (current 2001 Valley Metro):			
* Rev. Veh Hrs @ $96.52		9.41	$ millions
* Rev Veh Mi @ $6.26		11.17	$ millions
*** Total Annual O&M**		**10.29**	$ millions

All costs in Year 2001 Dollars

Bell Road
BRT - Fleet Sizing and O&M Estimate

Item			**Comments**	
				peak
Travel/Miles of Line	28.55	28.55		headway
Stations:				**5**
* Surface	see total -------------	29		on each line
* Aerial	see total -------------			
Operating Times:				
* 1-way run, minutes	*77.9*		Scottsdale to Loop 303, average WB/EB	
Round trip w/o recovery (min)	156		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**187**		average cycle	
Vehicle Fleet:				
* Buses in service (peak)	38	38	combined - 5' peak headways (H)	
* Fleet		46	In service + 20% spares	
Bus Hrs & Miles:				
* Bus Hours:				
- Daily	494	494	7 hr @ 5' H, 12 hr @ 10' H	
* Bus Hrs per day:				
- Base	494	494	Single vehicle, 19 hrs/day	
- Total	494	494		
* *Schedule* speed, mph	18.3		Includes dwell and recovery times	
* Bus miles per day	9,040	9,040		
* Annualization:			300 equivalent weekdays/year	
- Bus Hours	148,200	148,200		
- Bus Miles	2,712,000	2,712,000		
O&M Cost Estimates (current 2001 Valley Metro):				
* Rev. Veh Hrs @ $96.52		14.30	$ millions	
* Rev Veh Mi @ $6.26		16.98	$ millions	
*** Total Annual O&M**		**15.64**	$ millions	

All costs in Year 2001 Dollars

Camelback Road
BRT - Fleet Sizing and O&M Estimate

Item			Comments
			peak headway **5** on each line
Travel/Miles of Line	8.63	8.63	
Stations:			
* Surface	see total -------------	9	
* Aerial	see total -------------	-	
Operating Times:			
* 1-way run, minutes	*23.5*		Scottsdale to Loop 101, average WB/EB
Round trip w/o recovery (min)	47		excluding turn-around time at ends of line
* 2-way cycle, minutes	**57**		average cycle
Vehicle Fleet:			
* Buses in service (peak)	12	12	combined - 5' peak headways (H)
* Fleet		14	In service + 20% spares
Bus Hrs & Miles:			
* Bus Hours:			
- Daily	156	156	7 hr @ 5' H, 12 hr @ 10' H
* Bus Hrs per day:			
- Base	156	156	Single vehicle, 19 hrs/day
- Peak	0	-	
- Crush	-	-	
* *Schedule* speed, mph	18.1		Includes dwell and recovery times
* Bus miles per day	2,824	2,824	
* Annualization:			300 equivalent weekdays/year
- Bus Hours	46,800	46,800	
- Bus Miles	847,200	847,200	
O&M Cost Estimates (current 2001 Valley Metro):			
* Rev. Veh Hrs @ $96.52		4.52	$ millions
* Rev Veh Mi @ $6.26		5.30	$ millions
*** Total Annual O&M**		**4.91**	$ millions

All costs in Year 2001 Dollars

Chandler Boulevard

BRT - Fleet Sizing and O&M Estimate

Item			Comments	
				peak
Travel/Miles of Line	16.45	16.45		headway
Stations:				7
* Surface	see total -------------	17		on each line
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*44.9*		Ray to Power, average WB/EB	
Round trip w/o recovery (min)	90		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**108**		average cycle	
Vehicle Fleet:				
* Buses in service (peak)	16	16	combined - 7' peak headways (H)	
* Buses in service (off-peak)				
* Fleet		19	In service + 20% spares	
Bus Hrs & Miles:				
* Bus Hours:				
- Daily	208	208	7 hr @ 7' H, 12 hr @ 14' H	
* Bus Hrs per day:				
- Base	208	208	Single vehicle, 19 hrs/day	
- Peak	0	-		
- Crush	-	-		
- Total	208	208		
* *Schedule* speed, mph	18.3		Includes dwell and recovery times	
* Bus miles per day	3,806	3,806		
* Annualization:			300 equivalent weekdays/year	
- Bus Hours	62,400	62,400		
- Bus Miles	1,141,800	1,141,800		
O&M Cost Estimates (current 2001 Valley Metro):				
* Rev. Veh Hrs @ $96.52		6.02	$ millions	
* Rev Veh Mi @ $6.26		7.15	$ millions	
*** Total Annual O&M**		**6.59**	$ millions	

All costs in Year 2001 Dollars

Grand Avenue BRT

BRT - Fleet Sizing and O&M Estimate

Item			Comments	
				peak
Travel/Miles of Line	25.80	25.80		headway
Stations:				5
* Surface	see total -------------	13		on each line
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*91.1*		Loop 303 to Central, average NB/SB	
Round trip w/o recovery (min)	182		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**219**		average cycle	
Vehicle Fleet:				
* Buses in service (peak)	44	44	combined - 5' peak headways (H)	
* Buses in service (off-peak)				
* Fleet		53	In service + 20% spares	
Bus Hrs & Miles:				
* Bus Hours:				
- Daily	572	572	7 hr @ 5' H, 12 hr @ 10' H	
* Bus Hrs per day:				
- Base	572	572	Single vehicle, 19 hrs/day	
- Peak	0	-		
- Crush	-	-		
- Total	572	572		
* *Schedule* speed, mph	14.2		Includes dwell and recovery times	
* Bus miles per day	8,122	8,122		
* Annualization:			300 equivalent weekdays/year	
- Bus Hours	171,600	171,600		
- Bus Miles	2,436,600	2,436,600		
O&M Cost Estimates (current 2001 Valley Metro):				
* Rev. Veh Hrs @ $96.52		16.56	$ millions	
* Rev Veh Mi @ $6.26		15.25	$ millions	
*** Total Annual O&M**		**15.91**	$ millions	

Main Street
BRT - Fleet Sizing and O&M Estimate

Item			Comments	
				peak headway
Travel/Miles of Line	9.64	9.64		
Stations:				5
* Surface	see total -------------	10		on each line
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*26.3*		Alma School to Power, average WB/EB	
Round trip w/o recovery (min)	53		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**63**		average cycle	
Vehicle Fleet:				
* Buses in service (peak)	13	13	combined - 5' peak headways (H)	
* Buses in service (off-peak)				
* Fleet		16	In service + 20% spares	
Bus Hrs & Miles:				
* Bus Hours:				
- Daily	169	169	7 hr @ 5' H, 12 hr @ 10' H	
* Bus Hrs per day:				
- Base	169	169	Single vehicle, 19 hrs/day	
- Peak	0	-		
- Crush	-	-		
- Total	169	169		
* *Schedule* speed, mph	18.3		Includes dwell and recovery times	
* Bus miles per day	3,093	3,093		
* Annualization:			300 equivalent weekdays/year	
- Bus Hours	50,700	50,700		
- Bus Miles	927,900	927,900		
O&M Cost Estimates (current 2001 Valley Metro):				
* Rev. Veh Hrs @ $96.52		4.89	$ millions	
* Rev Veh Mi @ $6.26		5.81	$ millions	
*** Total Annual O&M**		**5.35**	$ millions	

All costs in Year 2001 Dollars

Power Road

BRT - Fleet Sizing and O&M Estimate

Item			Comments	
				peak
Travel/Miles of Line	13.04	13.04		headway
Stations:				10
* Surface	see total -------------	13		on each line
* Aerial	see total -------------	-		
Operating Times:				
* 1-way run, minutes	*35.6*		McDowell/Higley to Williams Field, average NB/SB	
Round trip w/o recovery (min)	71		excluding turn-around time at ends of line	
* 2-way cycle, minutes	**85**		average cycle	
Vehicle Fleet:				
* Buses in service (peak)	9	9	combined - 10' peak headways (H)	
* Buses in service (off-peak)				
* Fleet		11	In service + 20% spares	
Bus Hrs & Miles:				
* Bus Hours:				
- Daily	117	117	7 hr @ 10' H, 12 hr @ 20' H	
* Bus Hrs per day:				
- Base	117	117	Single vehicle, 19 hrs/day	
- Peak	0	-		
- Crush	-	-		
- Total	117	117		
* *Schedule* speed, mph	18.3		Includes dwell and recovery times	
* Bus miles per day	2,141	2,141		
* Annualization:			300 equivalent weekdays/year	
- Bus Hours	35,100	35,100		
- Bus Miles	642,300	642,300		
O&M Cost Estimates (current 2001 Valley Metro):				
* Rev. Veh Hrs @ $96.52		3.39	$ millions	
* Rev Veh Mi @ $6.26		4.02	$ millions	
*** Total Annual O&M**		**3.71**	$ millions	

All costs in Year 2001 Dollars

Scottsdale Road/UP Tempe Branch
BRT - Fleet Sizing and O&M Estimate

Item			Comments
			peak headway 5 on each line
Travel/Miles of Line	25.50	25.50	
Stations:			
* Surface	see total -------------	25	
* Aerial	see total -------------	-	
Operating Times:			
* 1-way run, minutes	*69.5*		Price/Queen Creek to Bell, average NB/SB
Round trip w/o recovery (min)	139		excluding turn-around time at ends of line
* 2-way cycle, minutes	**167**		average cycle
Vehicle Fleet:			
* Buses in service (peak)	34	34	combined - 5' peak headways (H)
* Buses in service (off-peak)			
* Fleet		41	In service + 20% spares
Bus Hrs & Miles:			
* Bus Hours:			
- Daily	442	442	7 hr @ 5' H, 12 hr @ 10' H
* Bus Hrs per day:			
- Base	442	442	Single vehicle, 19 hrs/day
- Peak	0	-	
- Crush	-	-	
- Total	442	442	
* *Schedule* speed, mph	18.3		Includes dwell and recovery times
* Bus miles per day	8,089	8,089	
* Annualization:			300 equivalent weekdays/year
- Bus Hours	132,600	132,600	
- Bus Miles	2,426,700	2,426,700	
O&M Cost Estimates (current 2001 Valley Metro):			
* Rev. Veh Hrs @ $96.52		12.80	$ millions
* Rev Veh Mi @ $6.26		15.19	$ millions
*** Total Annual O&M**		**14.00**	$ millions

All costs in Year 2001 Dollars

SR-51

BRT - Fleet Sizing and O&M Estimate

Item			Comments
			peak headway 5 on each line
Travel/Miles of Line	17.34	17.34	
Stations:			
* Surface	see total -------------	17	
* Aerial	see total -------------	-	
Operating Times:			
* 1-way run, minutes	*47.3*		Camelback/Central to Bell/Scottsdale, average WB/EB
Round trip w/o recovery (min)	95		excluding turn-around time at ends of line
* 2-way cycle, minutes	**113**		average cycle
Vehicle Fleet:			
* Buses in service (peak)	23	23	combined - 5' peak headways (H)
* Buses in service (off-peak)			
* Fleet		28	In service + 20% spares
Bus Hrs & Miles:			
* Bus Hours:			
- Daily	299	299	7 hr @ 5' H, 12 hr @ 10' H
* Bus Hrs per day:			
- Base	299	299	Single vehicle, 19 hrs/day
- Peak	0	-	
- Crush	-	-	
- Total	299	299	
* *Schedule* speed, mph	18.3		Includes dwell and recovery times
* Bus miles per day	5,472	5,472	
* Annualization:			300 equivalent weekdays/year
- Bus Hours	89,700	89,700	
- Bus Miles	1,641,600	1,641,600	
O&M Cost Estimates (current 2001 Valley Metro):			
* Rev. Veh Hrs @ $96.52		8.66	$ millions
* Rev Veh Mi @ $6.26		10.28	$ millions
* **Total Annual O&M**		**9.47**	$ millions

All costs in Year 2001 Dollars

Union Pacific Chandler Branch
BRT - Fleet Sizing and O&M Estimate

Item			Comments
			peak headway 5 on each line
Travel/Miles of Line	12.60	12.60	
Stations:			
* Surface	see total -------------	13	
* Aerial	see total -------------	-	
Operating Times:			
* 1-way run, minutes	*34.4*		Baseline to Price/Queen Creek, average NB/SB
Round trip w/o recovery (min)	69		excluding turn-around time at ends of line
* 2-way cycle, minutes	**82**		average cycle
Vehicle Fleet:			
* Buses in service (peak)	17	17	combined - 5' peak headways (H)
* Buses in service (off-peak)			
* Fleet		20	In service + 20% spares
Bus Hrs & Miles:			
* Bus Hours:			
- Daily	221	221	7 hr @ 5' H, 12 hr @ 10' H
* Bus Hrs per day:			
- Base	221	221	Single vehicle, 19 hrs/day
- Peak	0	-	
- Crush	-	-	
- Total	221	221	
* *Schedule* speed, mph	18.3		Includes dwell and recovery times
* Bus miles per day	4,044	4,044	
* Annualization:			300 equivalent weekdays/year
- Bus Hours	66,300	66,300	
- Bus Miles	1,213,200	1,213,200	
O&M Cost Estimates (current 2001 Valley Metro):			
* Rev. Veh Hrs @ $96.52		6.40	$ millions
* Rev Veh Mi @ $6.26		7.59	$ millions
*** Total Annual O&M**		**7.00**	$ millions

All costs in Year 2001 Dollars

Appendix D

SECTION 1: SUMMARY OF RESULTS

Scenario 1: Camelback Road LRT

TABLE 1A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

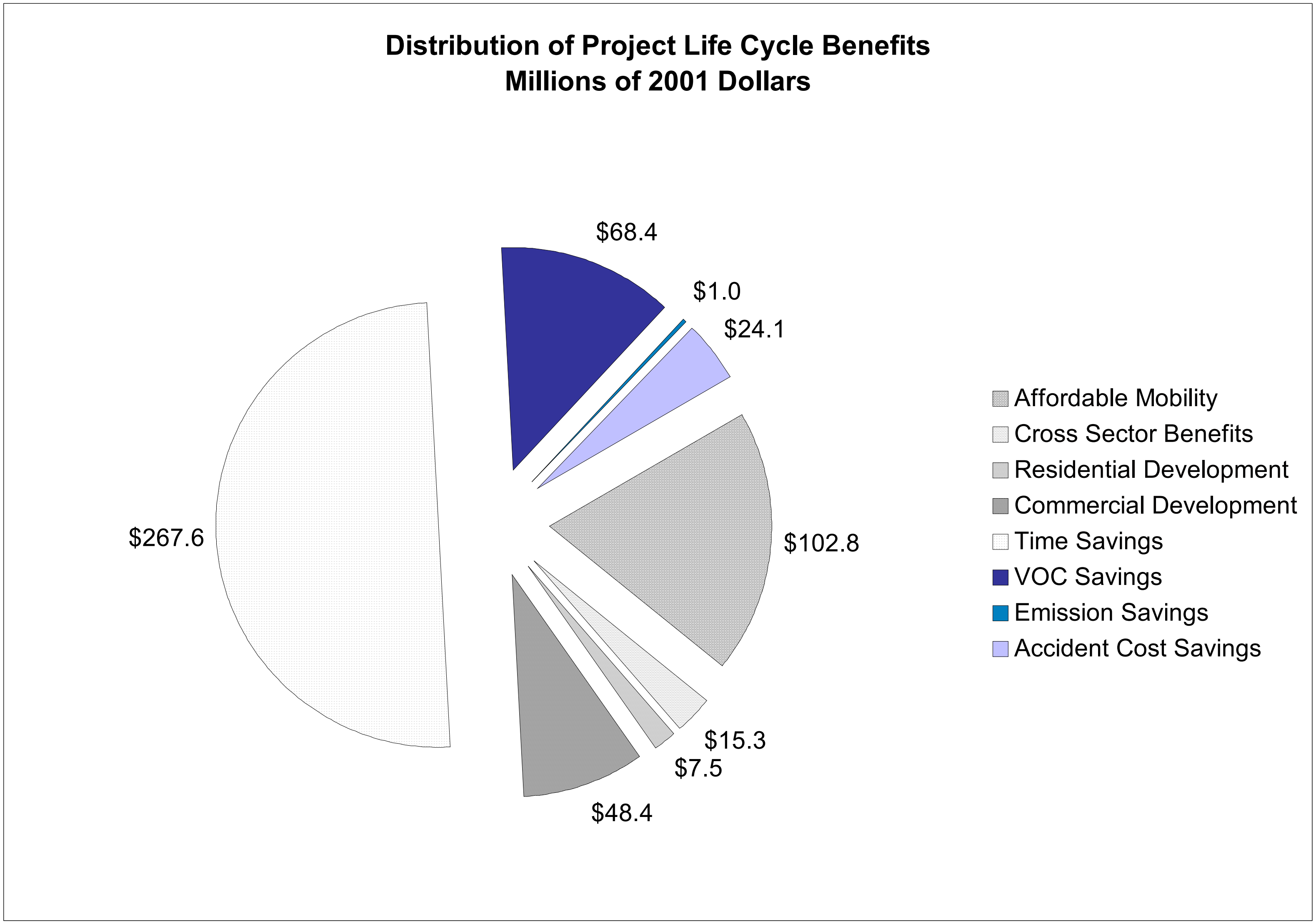
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$102.8	$68.9	$133.0	19.2%
Cross Sector Benefits	$15.3	$4.4	$31.5	2.9%
Total Low Income Mobility	**$118.1**	**$73.2**	**$164.5**	**22.1%**
Livable Community				
Residential Development	$7.5	$3.2	$12.2	1.4%
Commercial Development	$48.4	$32.9	$71.2	9.0%
Total Livable Community Benefits	**$55.8**	**$36.1**	**$83.4**	**10.4%**
Congestion Management				
Time Savings	$267.6	$127.8	$404.5	50.0%
VOC Savings	$68.4	$51.3	$82.7	12.8%
Emission Savings	$1.0	$0.4	$1.5	0.2%
Accident Cost Savings	$24.1	$12.3	$38.0	4.5%
Total Congestion Management	**$361.0**	**$191.8**	**$526.6**	**67.5%**
Grand Total Benefits	**$535.0**	**$301.2**	**$774.5**	**100.0%**
Total Costs	**$408.8**	**$408.8**	**$408.8**	
Net Present Value	**$126.1**	**($36.6)**	**$305.6**	
Benefit-Cost Ratio	**1.31**	**0.91**	**1.75**	
Internal Rate of Return, %	**5.93%**	**3.27%**	**8.45%**	
Payback Period, years	**19**	**14**	**23**	

TABLE 1B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$12.75	$9.02	$16.49	18.9%
Cross Sector Benefits	$1.90	$0.54	$3.86	2.8%
Total Low Income Mobility	**$14.65**	**$9.56**	**$20.35**	**21.7%**
Livable Community				
Residential Development	$1.14	$0.49	$1.86	1.7%
Commercial Development	$7.36	$4.87	$10.86	10.9%
Total Livable Community Benefits	**$8.51**	**$5.36**	**$12.71**	**12.6%**
Congestion Management				
Time Saving (min. per door-to-door trip)	15.3	7.8	20.1	--
Time Savings	$32.30	$12.46	$51.10	47.9%
VOC Savings	$8.86	$6.36	$10.77	13.1%
Emission Savings	$0.11	$0.05	$0.16	0.2%
Accident Cost Savings	$3.01	$1.50	$4.52	4.5%
Total Congestion Management	**$44.28**	**$20.37**	**$66.55**	**65.7%**
Grand Total Benefits	**$67.43**	**$35.29**	**$99.62**	**100.0%**

Scenario 1: Camelback Road LRT

Exhibit 1



Scenario 2: UP Chandler Branch LRT

TABLE 2A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

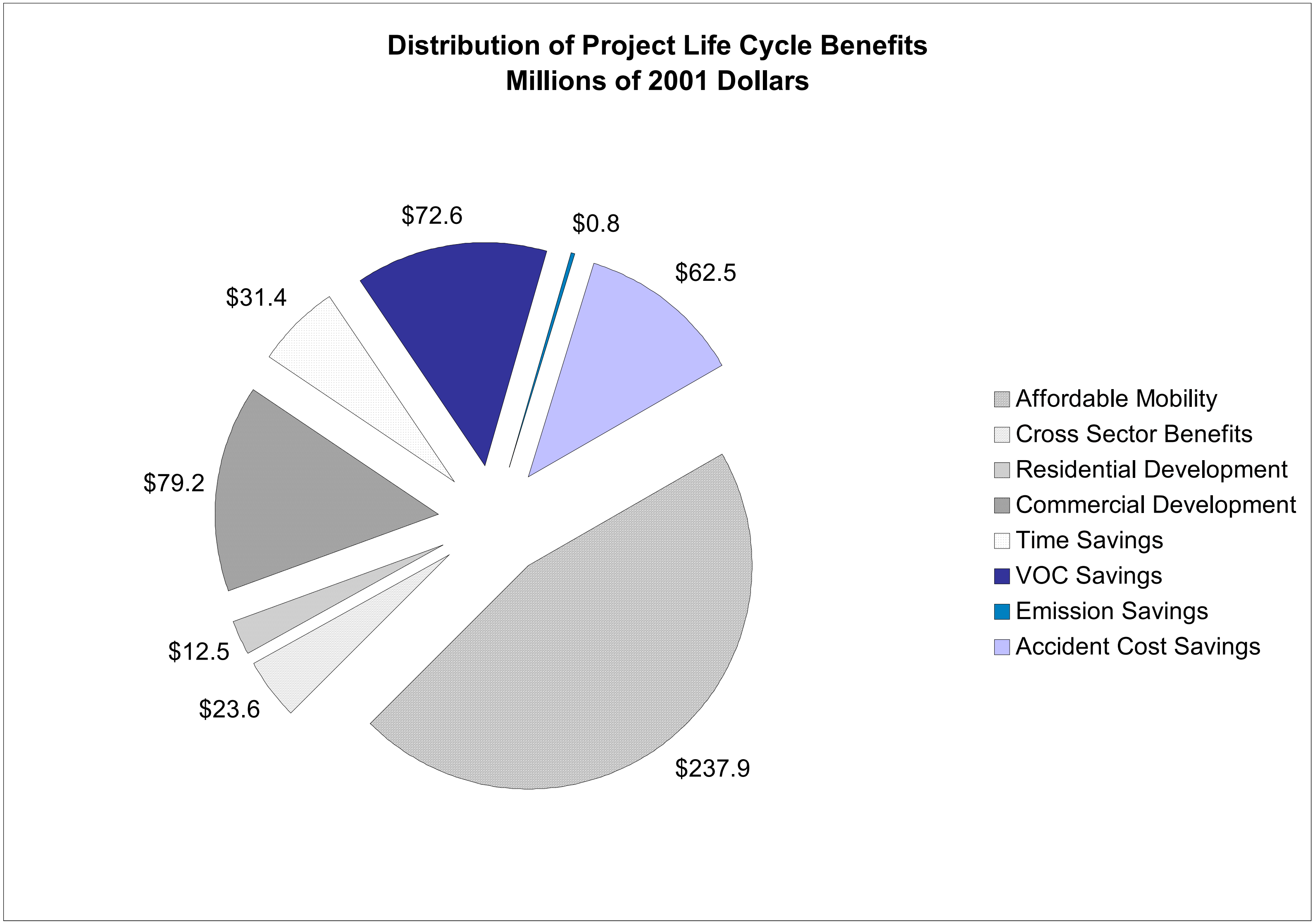
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$237.9	$160.8	$299.9	45.7%
Cross Sector Benefits	$23.6	$6.7	$48.6	4.5%
Total Low Income Mobility	**$261.5**	**$167.5**	**$348.4**	**50.2%**
Livable Community				
Residential Development	$12.5	$5.4	$20.4	2.4%
Commercial Development	$79.2	$52.9	$115.9	15.2%
Total Livable Community Benefits	**$91.7**	**$58.3**	**$136.3**	**17.6%**
Congestion Management				
Time Savings	$31.4	$20.9	$44.5	6.0%
VOC Savings	$72.6	$58.8	$84.3	13.9%
Emission Savings	$0.8	$0.4	$1.1	0.1%
Accident Cost Savings	$62.5	$33.3	$97.8	12.0%
Total Congestion Management	**$167.2**	**$113.3**	**$227.6**	**32.1%**
Grand Total Benefits	**$520.5**	**$339.1**	**$712.3**	**100.0%**
Total Costs	**$543.7**	**$543.7**	**$543.7**	
Net Present Value	**($23.3)**	**($132.3)**	**$84.4**	
Benefit-Cost Ratio	**0.96**	**0.76**	**1.16**	
Internal Rate of Return, %	**3.46%**	**1.42%**	**5.32%**	
Payback Period, years	**22**	**19**	**23**	

TABLE 2B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$29.51	$20.75	$37.30	44.2%
Cross Sector Benefits	$2.93	$0.84	$5.96	4.4%
Total Low Income Mobility	**$32.44**	**$21.59**	**$43.26**	**48.6%**
Livable Community				
Residential Development	$1.92	$0.83	$3.11	2.9%
Commercial Development	$12.07	$7.75	$17.30	18.1%
Total Livable Community Benefits	**$13.99**	**$8.58**	**$20.41**	**21.0%**
Congestion Management				
Time Saving (min. per door-to-door trip)	2.5	2.1	2.9	--
Time Savings	$3.50	$2.31	$5.00	5.2%
VOC Savings	$8.91	$7.32	$10.36	13.4%
Emission Savings	$0.08	$0.05	$0.12	0.1%
Accident Cost Savings	$7.79	$3.85	$12.39	11.7%
Total Congestion Management	**$20.28**	**$13.53**	**$27.87**	**30.4%**
Grand Total Benefits	**$66.71**	**$43.70**	**$91.53**	**100.0%**

Scenario 2: UP Chandler Branch LRT

Exhibit 2



Scenario 3: Main Street (Option 2) LRT

TABLE 3A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

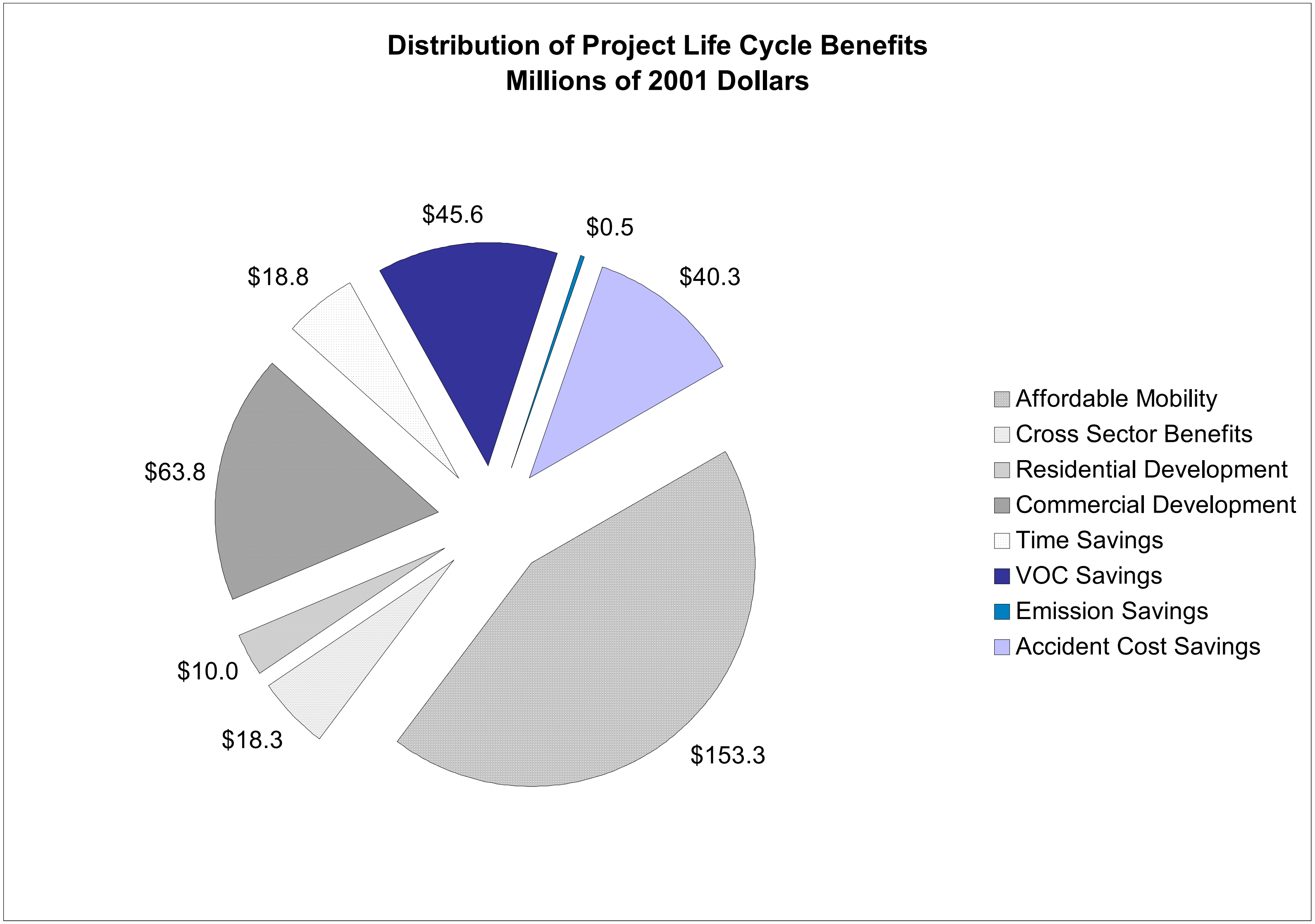
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$153.3	$103.3	$195.5	43.7%
Cross Sector Benefits	$18.3	$5.2	$37.6	5.2%
Total Low Income Mobility	**$171.6**	**$108.5**	**$233.1**	**49.0%**
Livable Community				
Residential Development	$10.0	$4.3	$16.3	2.9%
Commercial Development	$63.8	$43.0	$93.9	18.2%
Total Livable Community Benefits	**$73.8**	**$47.3**	**$110.2**	**21.0%**
Congestion Management				
Time Savings	$18.8	$12.5	$26.6	5.4%
VOC Savings	$45.6	$37.0	$52.9	13.0%
Emission Savings	$0.5	$0.3	$0.7	0.1%
Accident Cost Savings	$40.3	$21.3	$63.1	11.5%
Total Congestion Management	**$105.2**	**$71.1**	**$143.3**	**30.0%**
Grand Total Benefits	**$350.6**	**$227.0**	**$486.6**	**100.0%**
Total Costs	**$446.6**	**$446.6**	**$446.6**	
Net Present Value	**($96.0)**	**($167.8)**	**($27.3)**	
Benefit-Cost Ratio	**0.78**	**0.62**	**0.94**	
Internal Rate of Return, %	**1.63%**	**-0.44%**	**3.37%**	
Payback Period, years	**23**	**23**	**23**	

TABLE 3B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$19.02	$13.41	$24.26	42.0%
Cross Sector Benefits	$2.27	$0.65	$4.61	5.0%
Total Low Income Mobility	**$21.29**	**$14.06**	**$28.87**	**47.0%**
Livable Community				
Residential Development	$1.53	$0.66	$2.48	3.4%
Commercial Development	$9.72	$6.31	$14.01	21.4%
Total Livable Community Benefits	**$11.25**	**$6.97**	**$16.50**	**24.8%**
Congestion Management				
Time Saving (min. per door-to-door trip)	2.2	1.8	2.6	--
Time Savings	$2.10	$1.40	$2.97	4.6%
VOC Savings	$5.60	$4.60	$6.52	12.4%
Emission Savings	$0.05	$0.03	$0.07	0.1%
Accident Cost Savings	$5.02	$2.47	$8.24	11.1%
Total Congestion Management	**$12.77**	**$8.50**	**$17.81**	**28.2%**
Grand Total Benefits	**$45.31**	**$29.53**	**$63.17**	**100.0%**

Exhibit 3

Scenario 3: Main Street (Option 2) LRT



eScenario 4: Main Street (Option 2) BRT

TABLE 4A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

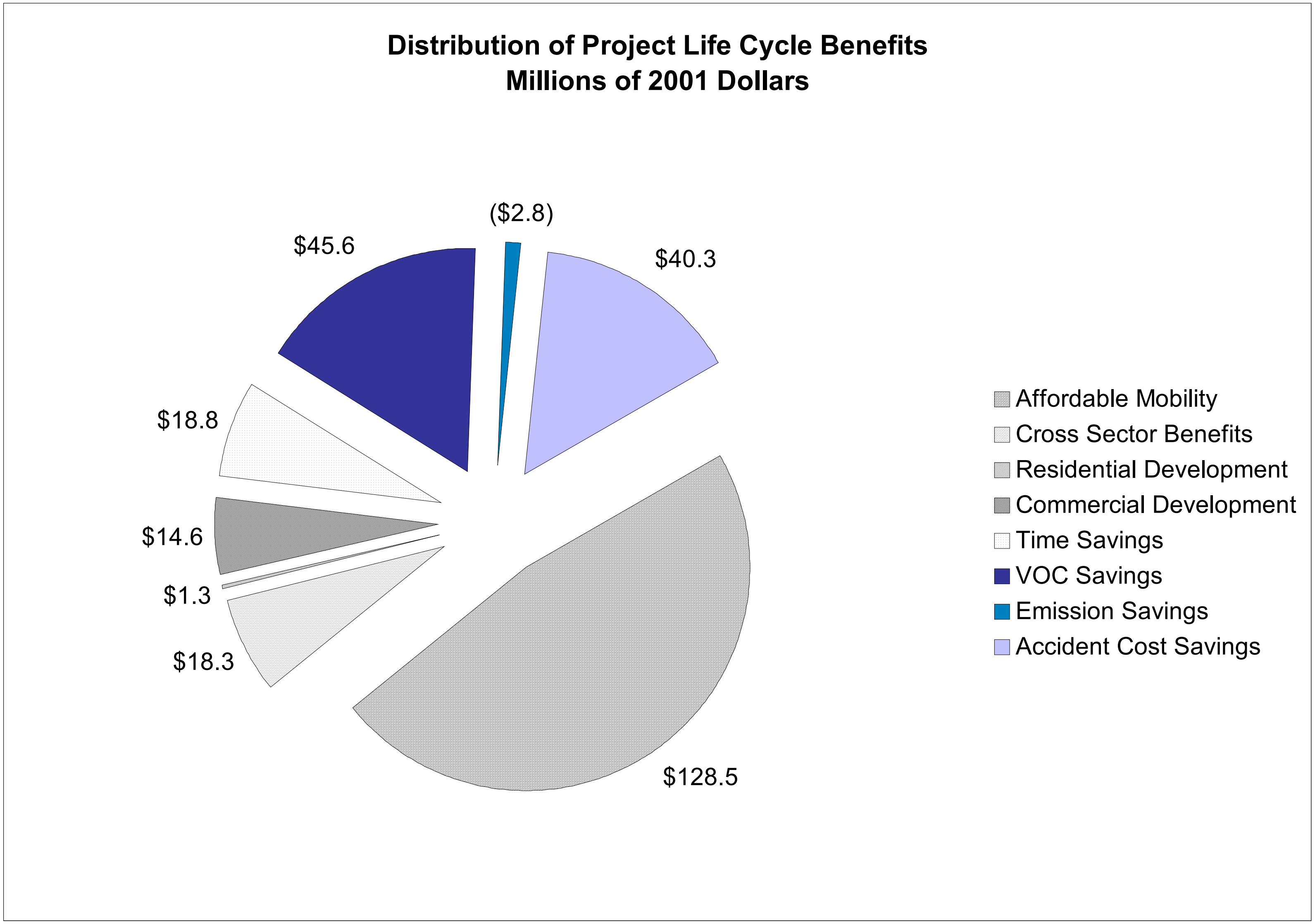
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$128.5	$86.3	$165.5	48.6%
Cross Sector Benefits	$18.3	$5.2	$37.6	6.9%
Total Low Income Mobility	**$146.8**	**$91.5**	**$203.1**	**55.5%**
Livable Community				
Residential Development	$1.3	$0.5	$2.2	0.5%
Commercial Development	$14.6	$8.9	$20.8	5.5%
Total Livable Community Benefits	**$15.9**	**$9.4**	**$23.1**	**6.0%**
Congestion Management				
Time Savings	$18.8	$12.5	$26.6	7.1%
VOC Savings	$45.6	$37.0	$52.9	17.2%
Emission Savings	($2.8)	($4.6)	($1.4)	-1.1%
Accident Cost Savings	$40.3	$21.3	$63.1	15.2%
Total Congestion Management	**$101.9**	**$66.3**	**$141.2**	**38.5%**
Grand Total Benefits	**$264.5**	**$167.2**	**$367.3**	**100.0%**
Total Costs	**$239.0**	**$239.0**	**$239.0**	
Net Present Value	**$25.5**	**($38.4)**	**$72.4**	
Benefit-Cost Ratio	**1.11**	**0.84**	**1.30**	
Internal Rate of Return, %	**4.82%**	**2.29%**	**6.69%**	
Payback Period, years	**20**	**16**	**23**	

TABLE 4B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$15.94	$11.16	$20.52	48.3%
Cross Sector Benefits	$2.27	$0.65	$4.61	6.9%
Total Low Income Mobility	**$18.20**	**$11.81**	**$25.12**	**55.2%**
Livable Community				
Residential Development	$0.19	$0.07	$0.33	0.6%
Commercial Development	$2.21	$1.34	$3.28	6.7%
Total Livable Community Benefits	**$2.40**	**$1.42**	**$3.61**	**7.3%**
Congestion Management				
Time Saving (min. per door-to-door trip)	2.2	1.8	2.6	--
Time Savings	$2.10	$1.40	$2.97	6.4%
VOC Savings	$5.60	$4.60	$6.52	17.0%
Emission Savings	($0.33)	($0.53)	($0.17)	-1.0%
Accident Cost Savings	$5.02	$2.47	$8.24	15.2%
Total Congestion Management	**$12.39**	**$7.94**	**$17.57**	**37.6%**
Grand Total Benefits	**$33.00**	**$21.17**	**$46.30**	**100.0%**

Scenario 4: Main Street (Option 2) BRT

Exhibit 4



Scenario 5: Metrocenter LRT

TABLE 5A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

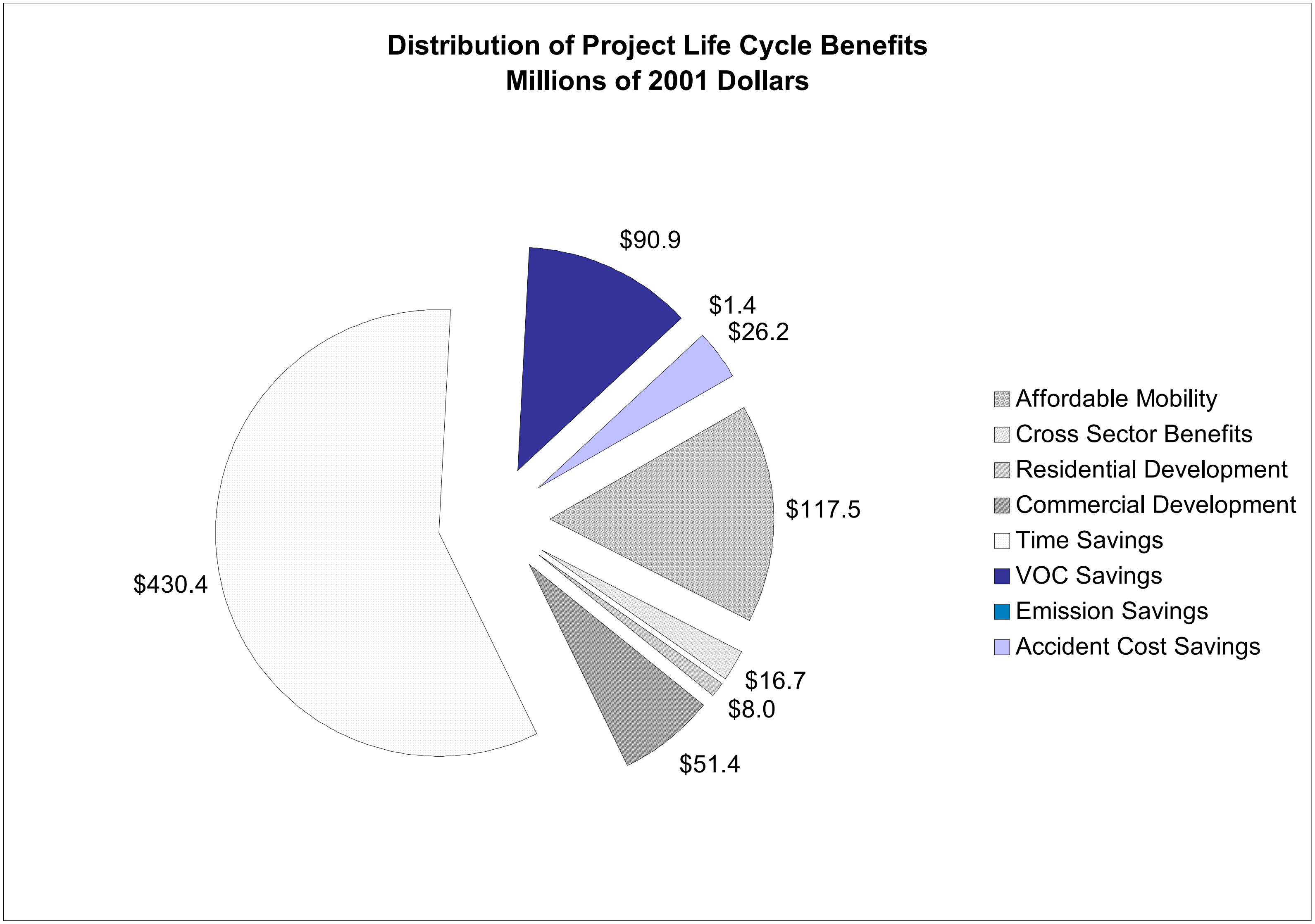
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$117.5	$78.8	$151.1	15.8%
Cross Sector Benefits	$16.7	$4.7	$34.3	2.2%
Total Low Income Mobility	**$134.2**	**$83.6**	**$185.4**	**18.1%**
Livable Community				
Residential Development	$8.0	$3.4	$13.0	1.1%
Commercial Development	$51.4	$35.1	$75.8	6.9%
Total Livable Community Benefits	**$59.4**	**$38.6**	**$88.9**	**8.0%**
Congestion Management				
Time Savings	$430.4	$261.4	$633.0	58.0%
VOC Savings	$90.9	$67.5	$109.0	12.2%
Emission Savings	$1.4	$0.6	$2.1	0.2%
Accident Cost Savings	$26.2	$12.1	$41.2	3.5%
Total Congestion Management	**$548.9**	**$341.6**	**$785.3**	**73.9%**
Grand Total Benefits	**$742.5**	**$463.7**	**$1,059.5**	**100.0%**
Total Costs	**$397.9**	**$397.9**	**$397.9**	
Net Present Value	**$344.6**	**$122.6**	**$570.1**	
Benefit-Cost Ratio	**1.87**	**1.31**	**2.43**	
Internal Rate of Return, %	**9.09%**	**6.01%**	**11.87%**	
Payback Period, years	**13**	**10**	**17**	

TABLE 5B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$14.58	$10.31	$18.80	15.1%
Cross Sector Benefits	$2.07	$0.59	$4.20	2.1%
Total Low Income Mobility	**$16.64**	**$10.90**	**$23.00**	**17.2%**
Livable Community				
Residential Development	$1.22	$0.53	$1.98	1.3%
Commercial Development	$7.84	$5.15	$11.45	8.1%
Total Livable Community Benefits	**$9.05**	**$5.68**	**$13.43**	**9.4%**
Congestion Management				
Time Saving (min. per door-to-door trip)	7.8	5.3	9.8	--
Time Savings	$55.15	$30.97	$76.40	57.0%
VOC Savings	$12.43	$9.02	$15.41	12.9%
Emission Savings	$0.17	$0.09	$0.25	0.2%
Accident Cost Savings	$3.26	$1.49	$5.12	3.4%
Total Congestion Management	**$71.01**	**$41.58**	**$97.18**	**73.4%**
Grand Total Benefits	**$96.70**	**$58.15**	**$133.61**	**100.0%**

Scenario 5: Metrocenter LRT

Exhibit 5



Scenario 6: Glendale Avenue LRT

TABLE 6A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

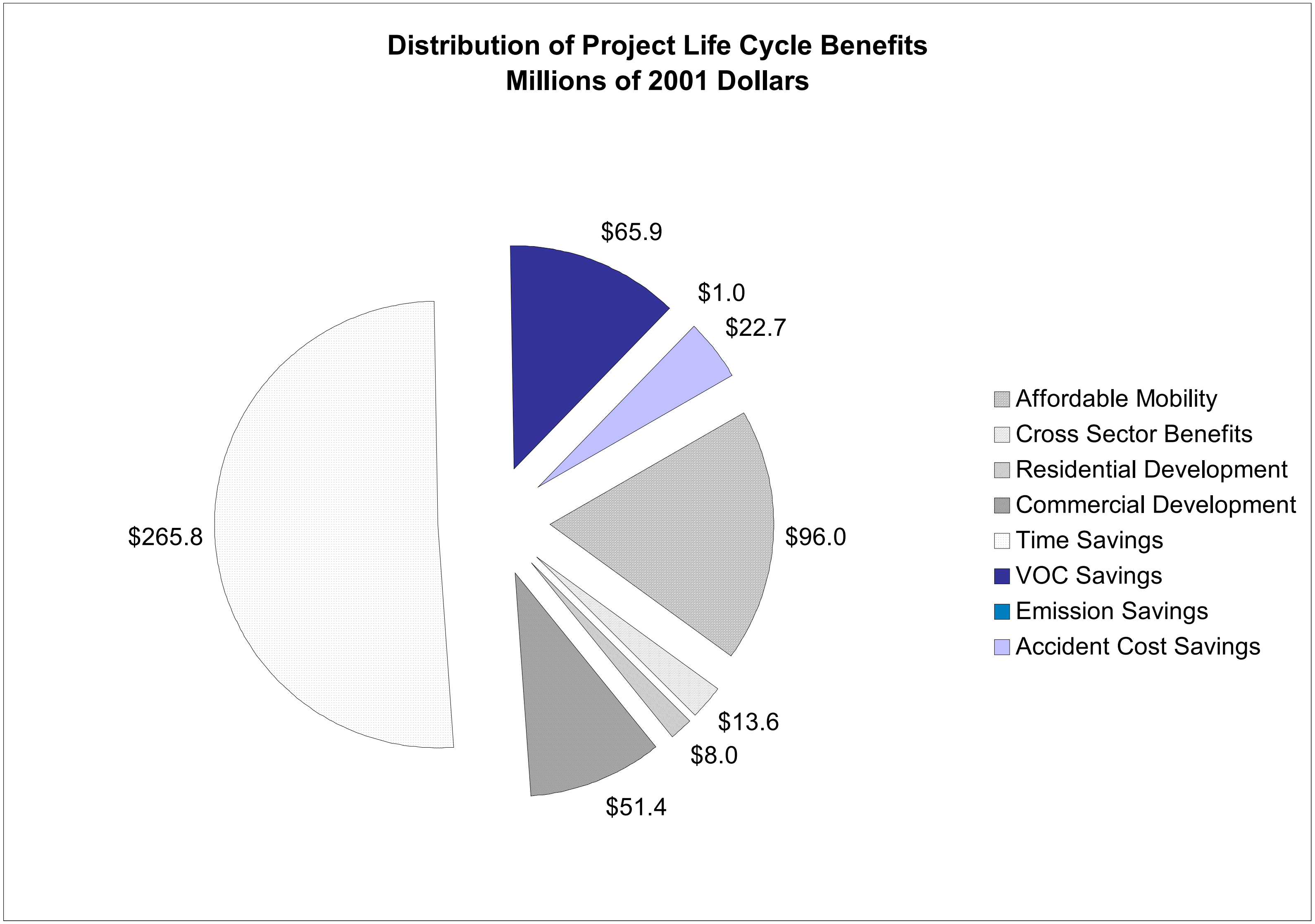
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$96.0	$64.4	$123.4	18.3%
Cross Sector Benefits	$13.6	$3.9	$28.0	2.6%
Total Low Income Mobility	**$109.6**	**$68.3**	**$151.4**	**20.9%**
Livable Community				
Residential Development	$8.0	$3.4	$13.0	1.5%
Commercial Development	$51.4	$35.1	$75.8	9.8%
Total Livable Community Benefits	**$59.4**	**$38.6**	**$88.9**	**11.3%**
Congestion Management				
Time Savings	$265.8	$131.6	$398.0	50.7%
VOC Savings	$65.9	$49.1	$79.5	12.6%
Emission Savings	$1.0	$0.4	$1.5	0.2%
Accident Cost Savings	$22.7	$11.6	$35.8	4.3%
Total Congestion Management	**$355.4**	**$192.7**	**$514.7**	**67.8%**
Grand Total Benefits	**$524.4**	**$299.5**	**$755.0**	**100.0%**
Total Costs	**$497.1**	**$497.1**	**$497.1**	
Net Present Value	**$27.3**	**($130.8)**	**$199.0**	
Benefit-Cost Ratio	**1.05**	**0.74**	**1.40**	
Internal Rate of Return, %	**4.21%**	**1.61%**	**6.69%**	
Payback Period, years	**21**	**16**	**23**	

TABLE 6B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$11.90	$8.42	$15.35	17.8%
Cross Sector Benefits	$1.69	$0.48	$3.43	2.5%
Total Low Income Mobility	**$13.59**	**$8.90**	**$18.78**	**20.3%**
Livable Community				
Residential Development	$1.22	$0.53	$1.98	1.8%
Commercial Development	$7.84	$5.15	$11.45	11.7%
Total Livable Community Benefits	**$9.05**	**$5.68**	**$13.43**	**13.5%**
Congestion Management				
Time Saving (min. per door-to-door trip)	15.6	8.1	19.9	--
Time Savings	$32.77	$12.91	$51.82	48.9%
VOC Savings	$8.67	$6.20	$10.57	12.9%
Emission Savings	$0.11	$0.05	$0.16	0.2%
Accident Cost Savings	$2.84	$1.42	$4.26	4.2%
Total Congestion Management	**$44.38**	**$20.58**	**$66.81**	**66.2%**
Grand Total Benefits	**$67.03**	**$35.16**	**$99.03**	**100.0%**

Scenario 6: Glendale Avenue LRT

Exhibit 6



Scenario 7: 59th Avenue LRT

TABLE 7A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

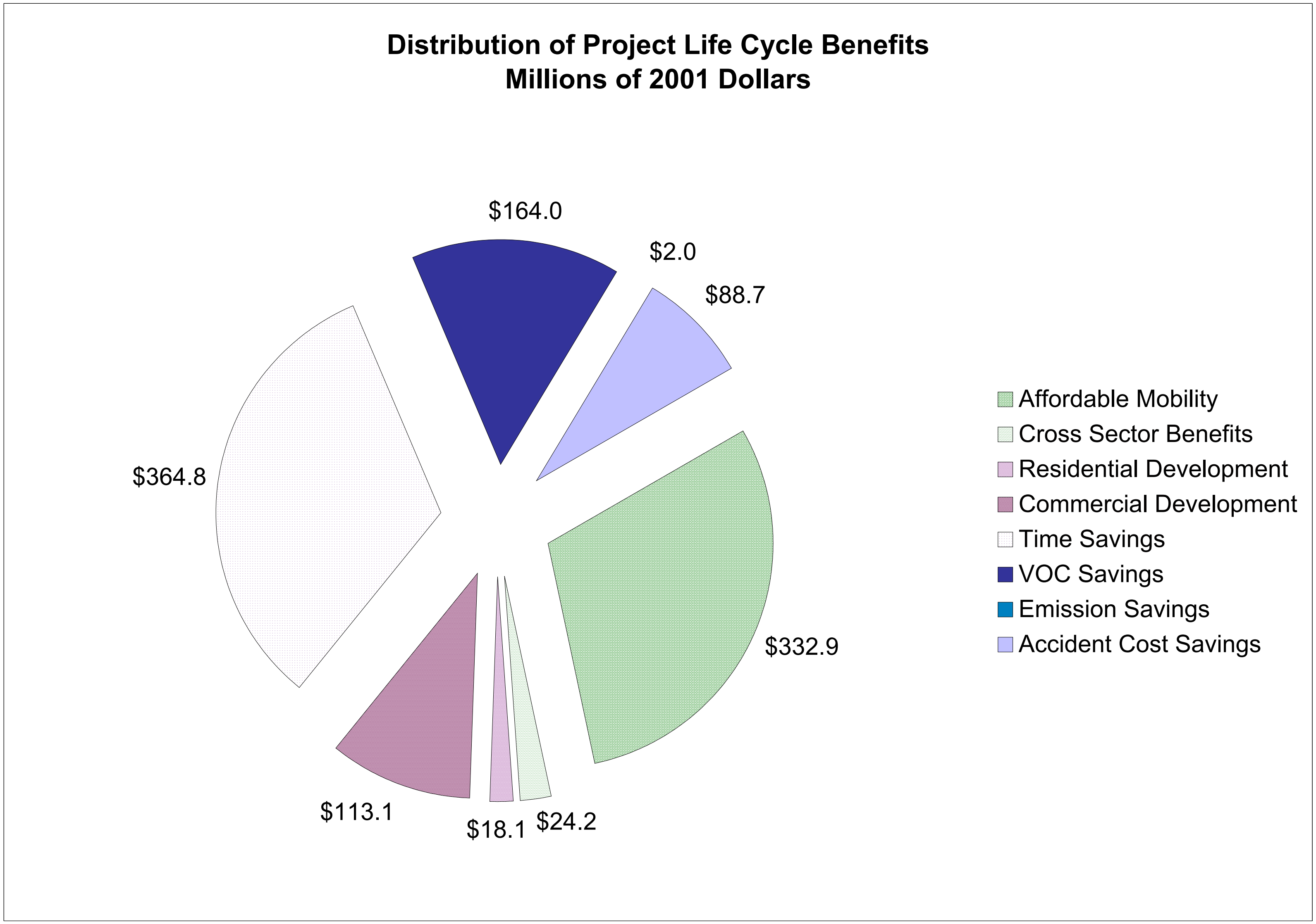
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$332.9	$225.9	$425.7	30.0%
Cross Sector Benefits	$24.2	$6.9	$49.7	2.2%
Total Low Income Mobility	**$357.1**	**$232.8**	**$475.4**	**32.2%**
Livable Community				
Residential Development	$18.1	$7.9	$29.4	1.6%
Commercial Development	$113.1	$74.6	$164.2	10.2%
Total Livable Community Benefits	**$131.2**	**$82.5**	**$193.6**	**11.8%**
Congestion Management				
Time Savings	$364.8	$128.4	$644.8	32.9%
VOC Savings	$164.0	$120.3	$203.8	14.8%
Emission Savings	$2.0	$0.9	$3.2	0.2%
Accident Cost Savings	$88.7	$47.4	$139.3	8.0%
Total Congestion Management	**$619.6**	**$297.0**	**$991.1**	**55.9%**
Grand Total Benefits	**$1,107.8**	**$612.3**	**$1,660.1**	**100.0%**
Total Costs	**$796.9**	**$796.9**	**$796.9**	
Net Present Value	**$310.9**	**$10.1**	**$640.2**	
Benefit-Cost Ratio	**1.39**	**1.01**	**1.80**	
Internal Rate of Return, %	**6.29%**	**4.05%**	**8.45%**	
Payback Period, years	**18**	**14**	**23**	

TABLE 7B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$41.29	$28.93	$51.99	31.6%
Cross Sector Benefits	$3.00	$0.86	$6.10	2.3%
Total Low Income Mobility	**$44.29**	**$29.79**	**$58.09**	**33.9%**
Livable Community				
Residential Development	$2.77	$1.21	$4.49	2.1%
Commercial Development	$17.24	$10.92	$24.52	13.2%
Total Livable Community Benefits	**$20.01**	**$12.13**	**$29.01**	**15.3%**
Congestion Management				
Time Saving (min. per door-to-door trip)	21.8	7.9	38.9	--
Time Savings	$35.72	$9.21	$65.58	27.4%
VOC Savings	$19.19	$12.65	$24.12	14.7%
Emission Savings	$0.22	$0.10	$0.31	0.2%
Accident Cost Savings	$11.07	$5.49	$17.15	8.5%
Total Congestion Management	**$66.20**	**$27.45**	**$107.17**	**50.7%**
Grand Total Benefits	**$130.50**	**$69.37**	**$194.26**	**100.0%**

Scenario 7: 59th Avenue LRT

Exhibit 7



Scenario 8: 59th Avenue BRT

TABLE 8A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

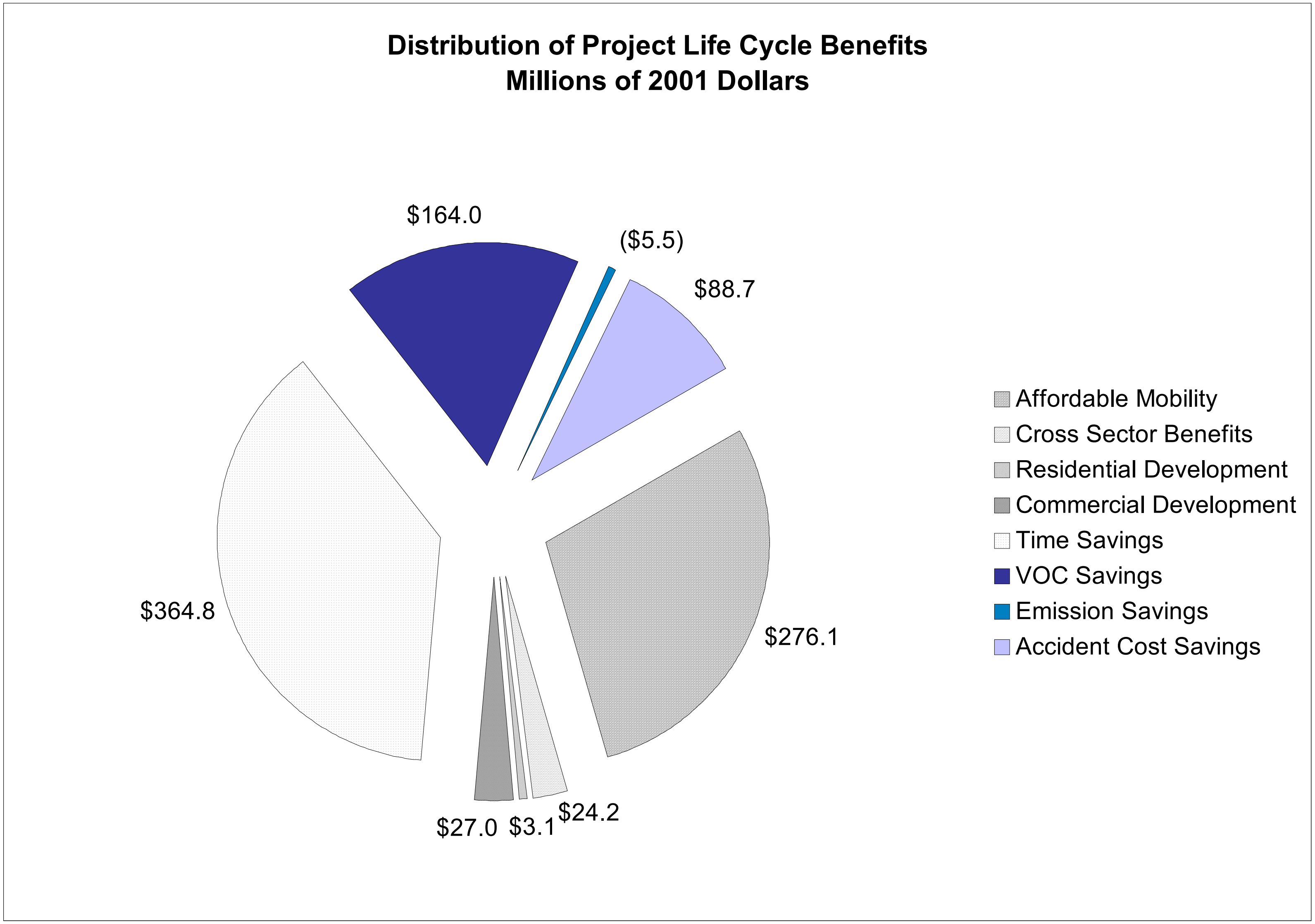
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$276.1	$187.1	$351.6	29.3%
Cross Sector Benefits	$24.2	$6.9	$49.7	2.6%
Total Low Income Mobility	**$300.3**	**$194.0**	**$401.4**	**31.9%**
Livable Community				
Residential Development	$3.1	$1.3	$5.1	0.3%
Commercial Development	$27.0	$17.2	$39.0	2.9%
Total Livable Community Benefits	**$30.0**	**$18.5**	**$44.1**	**3.2%**
Congestion Management				
Time Savings	$364.8	$128.4	$644.8	38.7%
VOC Savings	$164.0	$120.3	$203.8	17.4%
Emission Savings	($5.5)	($9.3)	($2.4)	-0.6%
Accident Cost Savings	$88.7	$47.4	$139.3	9.4%
Total Congestion Management	**$612.0**	**$286.8**	**$985.5**	**64.9%**
Grand Total Benefits	**$942.3**	**$499.2**	**$1,431.0**	**100.0%**
Total Costs	**$463.0**	**$463.0**	**$463.0**	
Net Present Value	**$479.3**	**$193.9**	**$813.0**	
Benefit-Cost Ratio	**2.04**	**1.42**	**2.76**	
Internal Rate of Return, %	**9.75%**	**7.18%**	**12.65%**	
Payback Period, years	**13**	**10**	**16**	

TABLE 8B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$34.24	$23.83	$42.48	32.0%
Cross Sector Benefits	$3.00	$0.86	$6.10	2.8%
Total Low Income Mobility	**$37.24**	**$24.68**	**$48.58**	**34.8%**
Livable Community				
Residential Development	$0.46	$0.19	$0.76	0.4%
Commercial Development	$4.11	$2.61	$5.98	3.8%
Total Livable Community Benefits	**$4.57**	**$2.80**	**$6.74**	**4.3%**
Congestion Management				
Time Saving (min. per door-to-door trip)	21.8	7.9	38.9	--
Time Savings	$35.72	$9.21	$65.58	33.3%
VOC Savings	$19.19	$12.65	$24.12	17.9%
Emission Savings	($0.65)	($1.11)	($0.30)	-0.6%
Accident Cost Savings	$11.07	$5.49	$17.15	10.3%
Total Congestion Management	**$65.33**	**$26.25**	**$106.56**	**61.0%**
Grand Total Benefits	**$107.14**	**$53.73**	**$161.88**	**100.0%**

Scenario 8: 59th Avenue BRT

Exhibit 8



Scenario 9: Bell Road LRT

TABLE 9A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

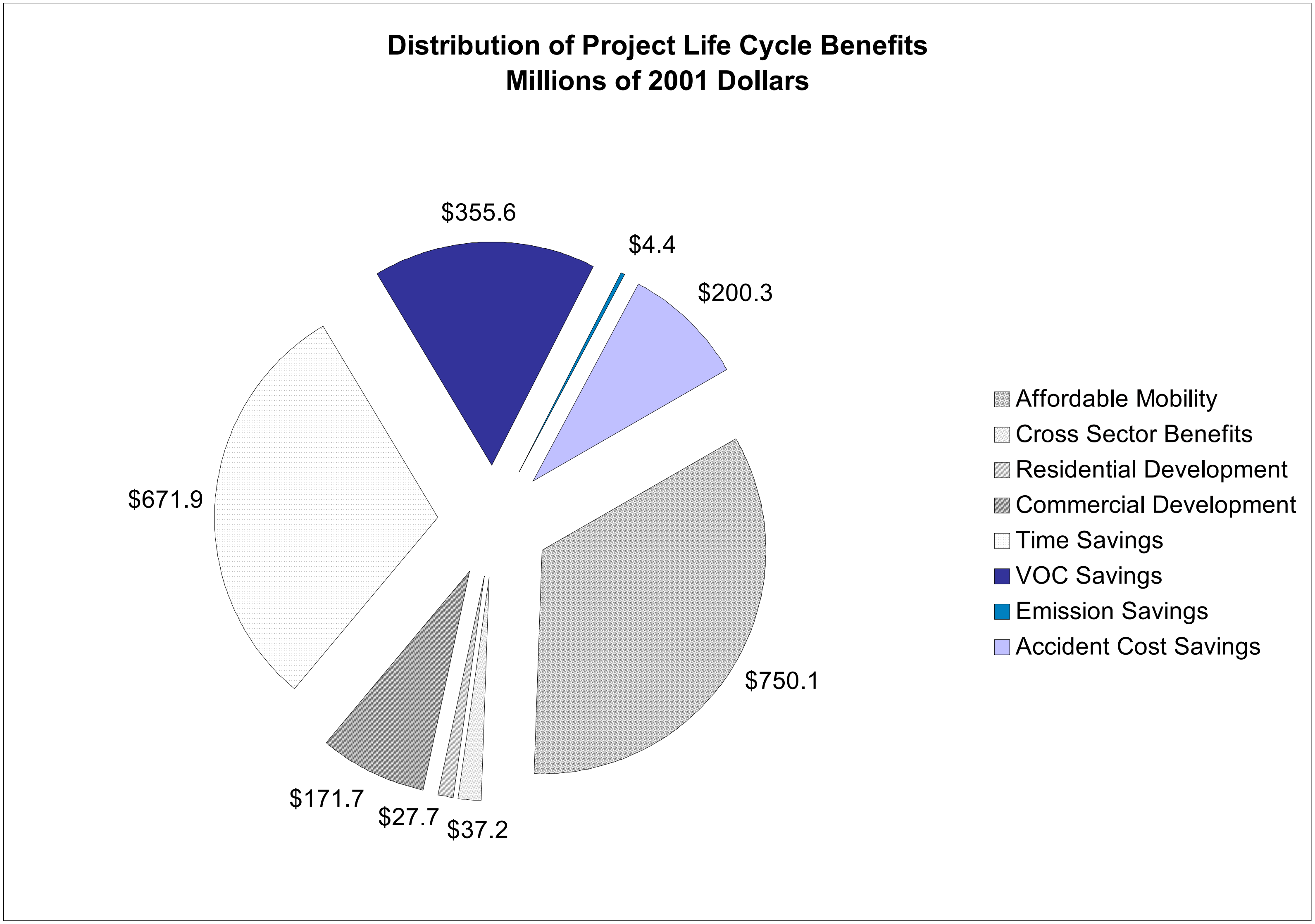
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$750.1	$511.1	$960.0	33.8%
Cross Sector Benefits	$37.2	$10.6	$76.5	1.7%
Total Low Income Mobility	**$787.4**	**$521.7**	**$1,036.5**	**35.5%**
Livable Community				
Residential Development	$27.7	$12.1	$45.0	1.2%
Commercial Development	$171.7	$112.1	$247.7	7.7%
Total Livable Community Benefits	**$199.4**	**$124.2**	**$292.7**	**9.0%**
Congestion Management				
Time Savings	$671.9	$242.1	$1,154.4	30.3%
VOC Savings	$355.6	$266.0	$434.2	16.0%
Emission Savings	$4.4	$2.0	$6.6	0.2%
Accident Cost Savings	$200.3	$102.4	$315.0	9.0%
Total Congestion Management	**$1,232.1**	**$612.4**	**$1,910.1**	**55.5%**
Grand Total Benefits	**$2,218.9**	**$1,258.3**	**$3,239.3**	**100.0%**
Total Costs	**$1,271.6**	**$1,271.6**	**$1,271.6**	
Net Present Value	**$947.4**	**$374.1**	**$1,536.9**	
Benefit-Cost Ratio	**1.75**	**1.29**	**2.21**	
Internal Rate of Return, %	**8.38%**	**6.20%**	**10.40%**	
Payback Period, years	**14**	**11**	**17**	

TABLE 9B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$93.05	$65.01	$114.84	35.6%
Cross Sector Benefits	$4.61	$1.32	$9.38	1.8%
Total Low Income Mobility	**$97.67**	**$66.33**	**$124.23**	**37.3%**
Livable Community				
Residential Development	$4.25	$1.86	$6.87	1.6%
Commercial Development	$26.18	$16.40	$37.00	10.0%
Total Livable Community Benefits	**$30.43**	**$18.25**	**$43.87**	**11.6%**
Congestion Management				
Time Saving (min. per door-to-door trip)	34.4	13.0	59.7	--
Time Savings	$66.27	$17.51	$119.57	25.3%
VOC Savings	$41.82	$28.90	$51.89	16.0%
Emission Savings	$0.46	$0.22	$0.67	0.2%
Accident Cost Savings	$25.01	$12.42	$37.76	9.6%
Total Congestion Management	**$133.56**	**$59.05**	**$209.88**	**51.0%**
Grand Total Benefits	**$261.65**	**$143.63**	**$377.98**	**100.0%**

Scenario 9: Bell Road LRT

Exhibit 9



Scenario 10: Chandler Boulevard LRT

TABLE 10A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

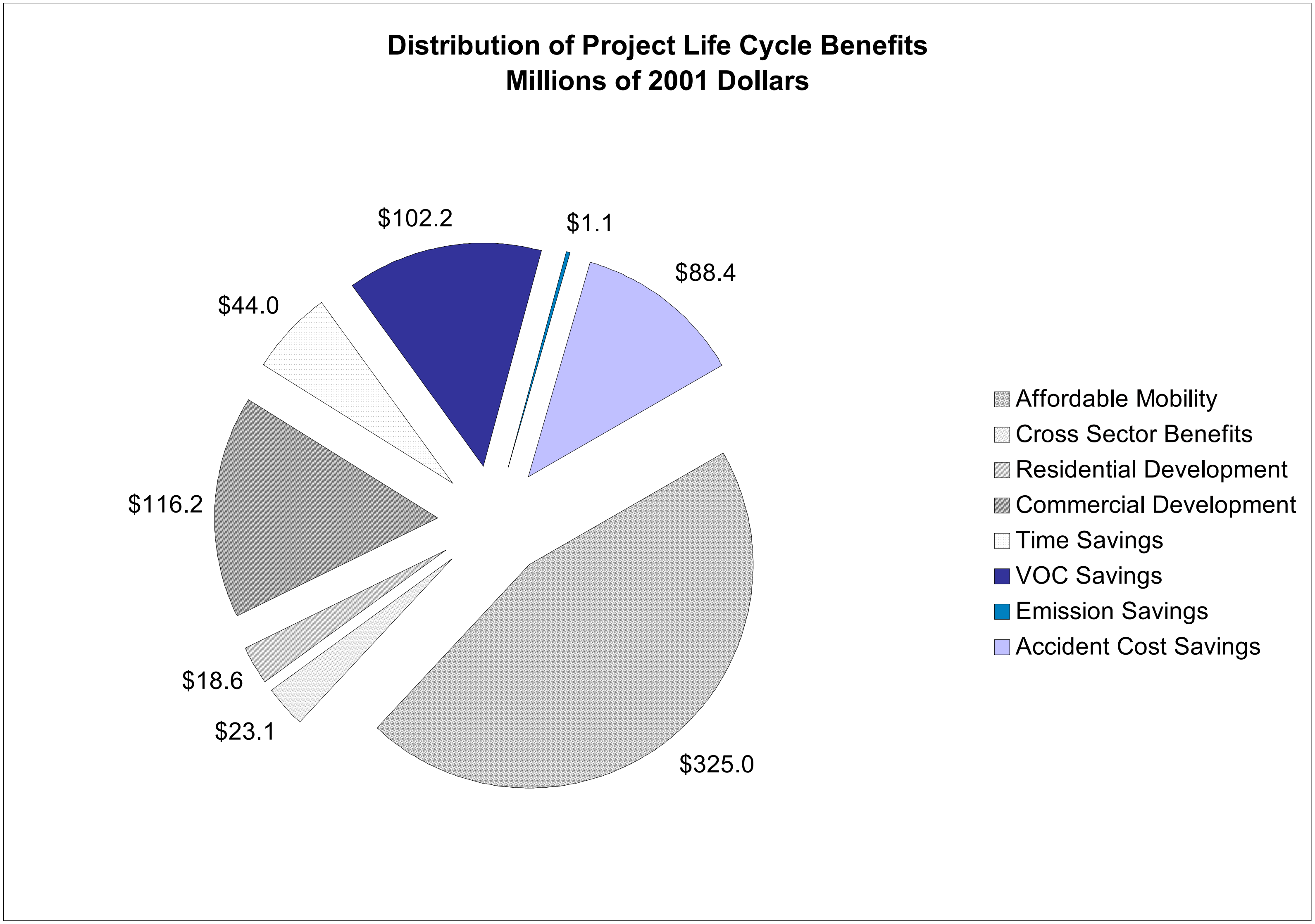
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$325.0	$220.6	$415.6	45.2%
Cross Sector Benefits	$23.1	$6.6	$47.4	3.2%
Total Low Income Mobility	**$348.0**	**$227.2**	**$463.0**	**48.4%**
Livable Community				
Residential Development	$18.6	$8.1	$30.2	2.6%
Commercial Development	$116.2	$76.6	$168.6	16.2%
Total Livable Community Benefits	**$134.8**	**$84.7**	**$198.8**	**18.8%**
Congestion Management				
Time Savings	$44.0	$29.3	$62.4	6.1%
VOC Savings	$102.2	$82.8	$118.7	14.2%
Emission Savings	$1.1	$0.6	$1.5	0.1%
Accident Cost Savings	$88.4	$47.0	$138.1	12.3%
Total Congestion Management	**$235.7**	**$159.7**	**$320.7**	**32.8%**
Grand Total Benefits	**$718.5**	**$471.5**	**$982.5**	**100.0%**
Total Costs	**$738.1**	**$738.1**	**$738.1**	
Net Present Value	**($19.6)**	**($166.1)**	**$108.2**	
Benefit-Cost Ratio	**0.97**	**0.77**	**1.15**	
Internal Rate of Return, %	**3.67%**	**1.90%**	**5.13%**	
Payback Period, years	**22**	**19**	**23**	

TABLE 10B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$40.31	$28.24	$50.67	43.7%
Cross Sector Benefits	$2.86	$0.82	$5.81	3.1%
Total Low Income Mobility	**$43.17**	**$29.06**	**$56.48**	**46.8%**
Livable Community				
Residential Development	$2.85	$1.24	$4.61	3.1%
Commercial Development	$17.71	$11.21	$25.18	19.2%
Total Livable Community Benefits	**$20.56**	**$12.45**	**$29.79**	**22.3%**
Congestion Management				
Time Saving (min. per door-to-door trip)	3.6	3.1	4.2	--
Time Savings	$4.91	$3.24	$7.01	5.3%
VOC Savings	$12.55	$10.32	$14.60	13.6%
Emission Savings	$0.12	$0.07	$0.16	0.1%
Accident Cost Savings	$11.02	$5.43	$17.61	11.9%
Total Congestion Management	**$28.59**	**$19.06**	**$39.38**	**31.0%**
Grand Total Benefits	**$92.32**	**$60.57**	**$125.65**	**100.0%**

Scenario 10: Chandler Boulevard LRT

Exhibit 10



Scenario 11: I-10 West LRT

TABLE 11A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

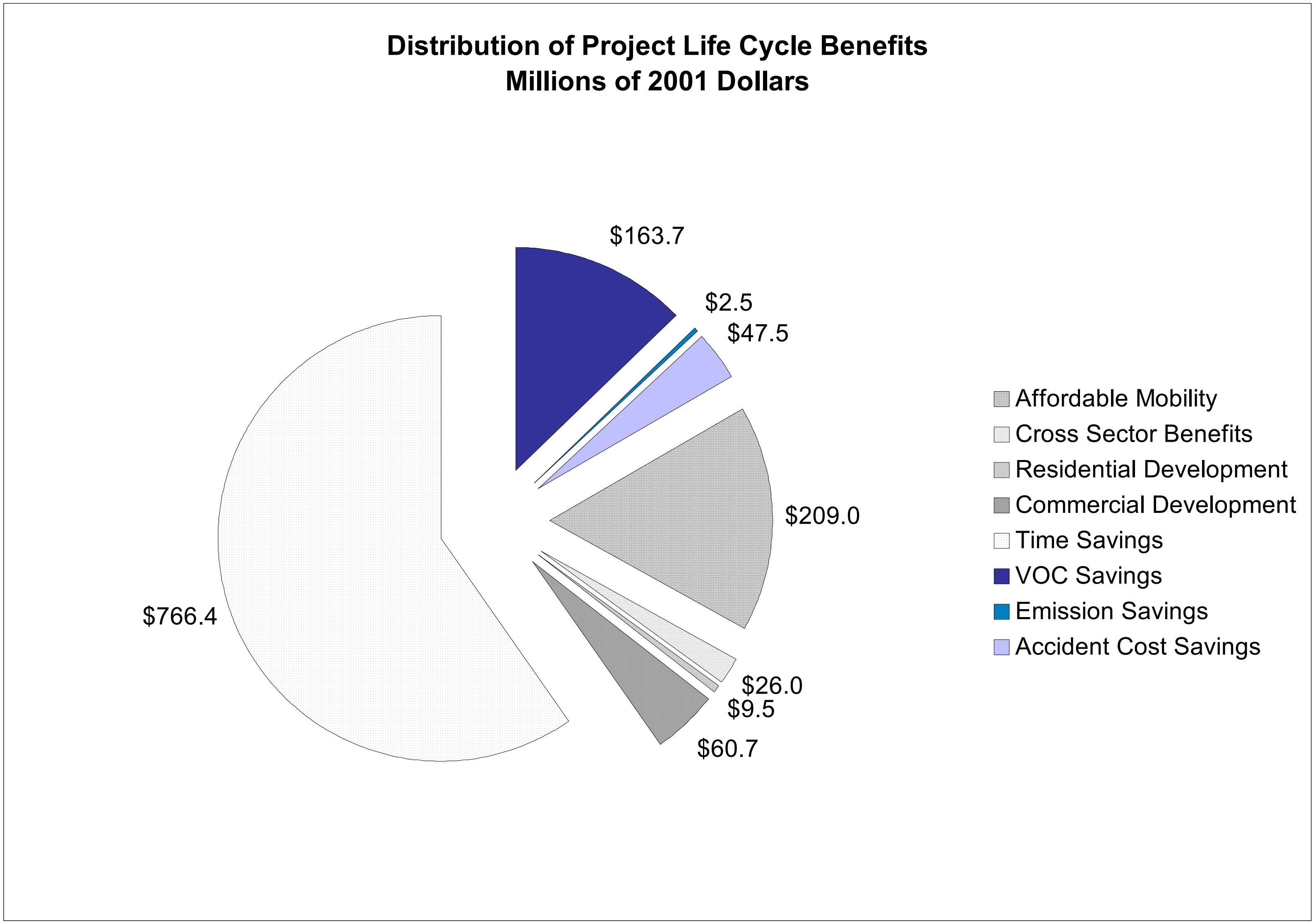
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$209.0	$140.6	$266.8	16.3%
Cross Sector Benefits	$26.0	$7.4	$53.3	2.0%
Total Low Income Mobility	**$234.9**	**$148.0**	**$320.1**	**18.3%**
Livable Community				
Residential Development	$9.5	$4.1	$15.5	0.7%
Commercial Development	$60.7	$41.0	$89.5	4.7%
Total Livable Community Benefits	**$70.2**	**$45.1**	**$105.0**	**5.5%**
Congestion Management				
Time Savings	$766.4	$463.7	$1,119.7	59.6%
VOC Savings	$163.7	$121.3	$197.0	12.7%
Emission Savings	$2.5	$1.1	$3.8	0.2%
Accident Cost Savings	$47.5	$22.0	$74.7	3.7%
Total Congestion Management	**$980.2**	**$608.0**	**$1,395.3**	**76.3%**
Grand Total Benefits	**$1,285.3**	**$801.2**	**$1,820.4**	**100.0%**
Total Costs	**$486.0**	**$486.0**	**$486.0**	
Net Present Value	**$799.3**	**$396.3**	**$1,206.1**	
Benefit-Cost Ratio	**2.64**	**1.82**	**3.48**	
Internal Rate of Return, %	**12.49%**	**8.74%**	**15.58%**	
Payback Period, years	**9**	**6**	**13**	

TABLE 11B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$25.92	$18.29	$33.06	15.5%
Cross Sector Benefits	$3.22	$0.92	$6.54	1.9%
Total Low Income Mobility	**$29.14**	**$19.20**	**$39.60**	**17.4%**
Livable Community				
Residential Development	$1.45	$0.63	$2.36	0.9%
Commercial Development	$9.25	$6.02	$13.36	5.5%
Total Livable Community Benefits	**$10.70**	**$6.65**	**$15.71**	**6.4%**
Congestion Management				
Time Saving (min. per door-to-door trip)	10.0	6.9	12.4	--
Time Savings	$98.52	$57.13	$134.86	59.0%
VOC Savings	$22.43	$16.16	$27.41	13.4%
Emission Savings	$0.30	$0.16	$0.44	0.2%
Accident Cost Savings	$5.92	$2.71	$9.30	3.5%
Total Congestion Management	**$127.17**	**$76.16**	**$172.01**	**76.1%**
Grand Total Benefits	**$167.01**	**$102.01**	**$227.32**	**100.0%**

Scenario 11: I-10 West LRT

Exhibit 11



Scenario 12: Power Road LRT

TABLE 12A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

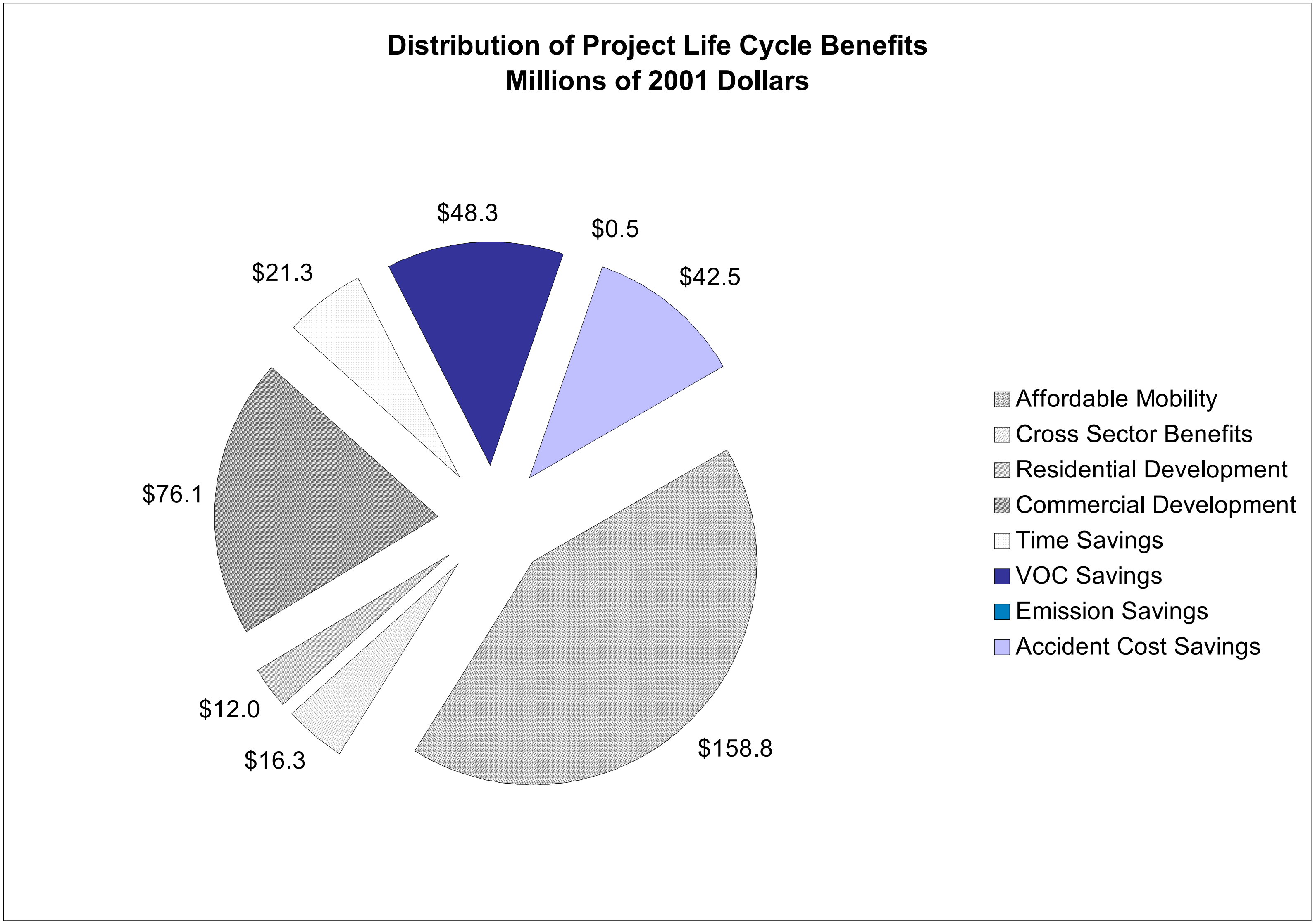
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$158.8	$107.2	$199.5	42.2%
Cross Sector Benefits	$16.3	$4.6	$33.5	4.3%
Total Low Income Mobility	**$175.1**	**$111.9**	**$233.1**	**46.6%**
Livable Community				
Residential Development	$12.0	$5.2	$19.6	3.2%
Commercial Development	$76.1	$50.9	$111.5	20.3%
Total Livable Community Benefits	**$88.1**	**$56.1**	**$131.1**	**23.5%**
Congestion Management				
Time Savings	$21.3	$14.1	$30.2	5.7%
VOC Savings	$48.3	$39.1	$56.1	12.9%
Emission Savings	$0.5	$0.3	$0.7	0.1%
Accident Cost Savings	$42.5	$22.5	$66.6	11.3%
Total Congestion Management	**$112.6**	**$76.0**	**$153.6**	**30.0%**
Grand Total Benefits	**$375.8**	**$244.0**	**$517.7**	**100.0%**
Total Costs	**$522.4**	**$522.4**	**$522.4**	
Net Present Value	**($146.6)**	**($222.9)**	**($72.8)**	
Benefit-Cost Ratio	**0.72**	**0.57**	**0.86**	
Internal Rate of Return, %	**1.10%**	**-0.73%**	**2.78%**	
Payback Period, years	**23**	**23**	**23**	

TABLE 12B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$19.69	$13.85	$24.93	40.4%
Cross Sector Benefits	$2.02	$0.58	$4.11	4.1%
Total Low Income Mobility	**$21.72**	**$14.43**	**$29.04**	**44.5%**
Livable Community				
Residential Development	$1.84	$0.80	$2.98	3.8%
Commercial Development	$11.60	$7.46	$16.64	23.8%
Total Livable Community Benefits	**$13.44**	**$8.26**	**$19.62**	**27.5%**
Congestion Management				
Time Saving (min. per door-to-door trip)	2.4	2.0	2.7	--
Time Savings	$2.37	$1.55	$3.40	4.9%
VOC Savings	$5.93	$4.88	$6.90	12.1%
Emission Savings	$0.06	$0.03	$0.08	0.1%
Accident Cost Savings	$5.29	$2.60	$8.72	10.8%
Total Congestion Management	**$13.65**	**$9.07**	**$19.09**	**28.0%**
Grand Total Benefits	**$48.80**	**$31.76**	**$67.75**	**100.0%**

Exhibit 12

Scenario 12: Power Road LRT



Scenario 13: Scottsdale/UP Tempe LRT

TABLE 13A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

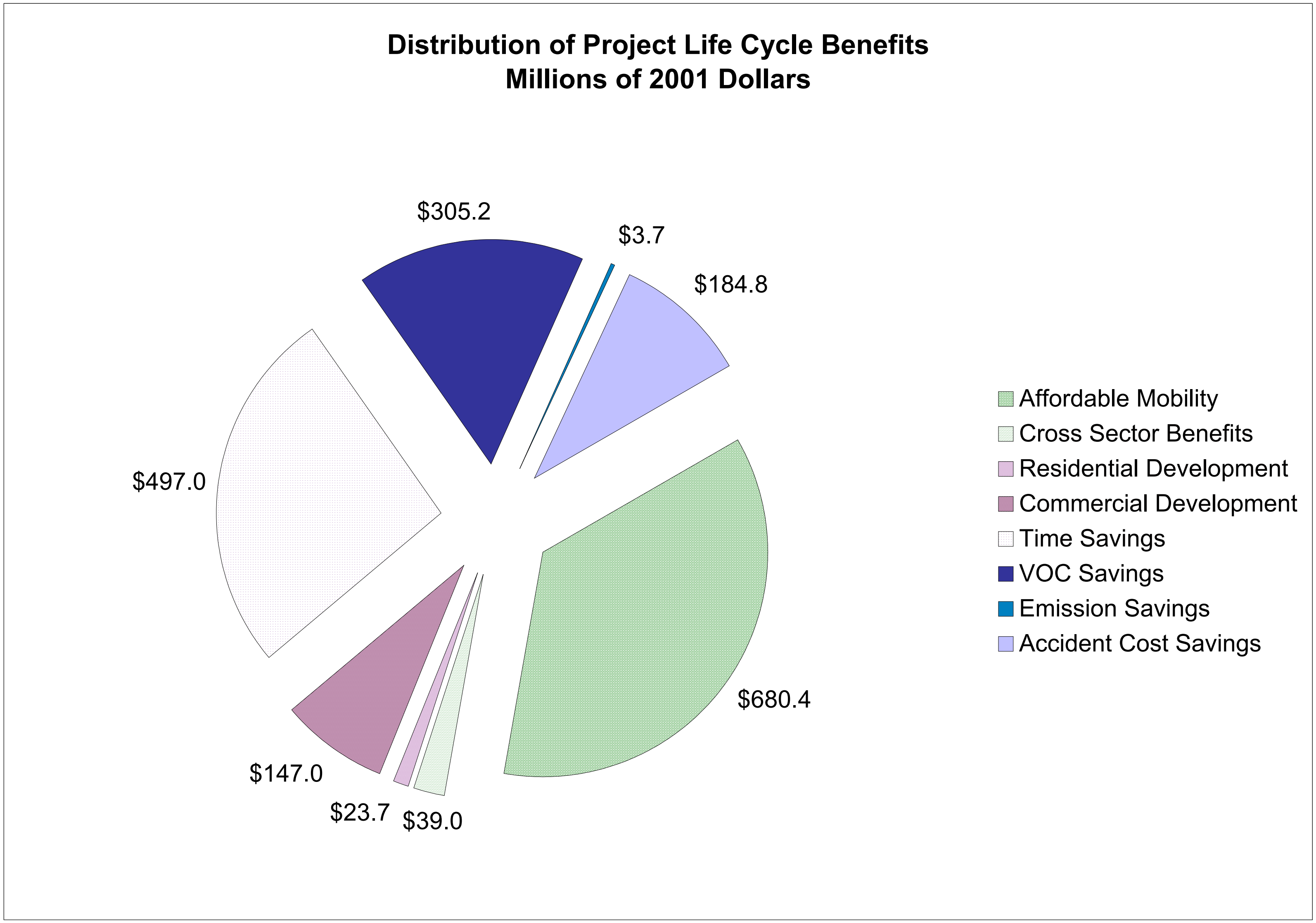
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$680.4	$463.0	$870.5	36.2%
Cross Sector Benefits	$39.0	$11.1	$80.1	2.1%
Total Low Income Mobility	**$719.3**	**$474.1**	**$950.6**	**38.2%**
Livable Community				
Residential Development	$23.7	$10.3	$38.4	1.3%
Commercial Development	$147.0	$96.3	$212.6	7.8%
Total Livable Community Benefits	**$170.7**	**$106.6**	**$251.0**	**9.1%**
Congestion Management				
Time Savings	$497.0	$180.8	$842.0	26.4%
VOC Savings	$305.2	$229.9	$367.8	16.2%
Emission Savings	$3.7	$1.7	$5.4	0.2%
Accident Cost Savings	$184.8	$98.4	$289.8	9.8%
Total Congestion Management	**$990.7**	**$510.8**	**$1,505.0**	**52.7%**
Grand Total Benefits	**$1,880.8**	**$1,091.5**	**$2,706.6**	**100.0%**
Total Costs	**$1,169.4**	**$1,169.4**	**$1,169.4**	
Net Present Value	**$711.4**	**$283.2**	**$1,139.5**	
Benefit-Cost Ratio	**1.61**	**1.24**	**1.97**	
Internal Rate of Return, %	**7.79%**	**5.91%**	**9.91%**	
Payback Period, years	**15**	**12**	**18**	

TABLE 13B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$84.40	$59.02	$104.63	37.6%
Cross Sector Benefits	$4.83	$1.38	$9.82	2.2%
Total Low Income Mobility	**$89.23**	**$60.40**	**$114.46**	**39.8%**
Livable Community				
Residential Development	$3.62	$1.58	$5.87	1.6%
Commercial Development	$22.42	$14.09	$31.75	10.0%
Total Livable Community Benefits	**$26.04**	**$15.67**	**$37.61**	**11.6%**
Congestion Management				
Time Saving (min. per door-to-door trip)	30.7	12.1	52.5	--
Time Savings	$49.55	$13.25	$88.37	22.1%
VOC Savings	$36.09	$25.77	$44.41	16.1%
Emission Savings	$0.39	$0.19	$0.56	0.2%
Accident Cost Savings	$23.05	$11.41	$36.34	10.3%
Total Congestion Management	**$109.08**	**$50.62**	**$169.69**	**48.6%**
Grand Total Benefits	**$224.35**	**$126.70**	**$321.76**	**100.0%**

Exhibit 13

Scenario 13: Scottsdale/UP Tempe LRT



Scenario 14: SR-51 LRT

TABLE 14A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

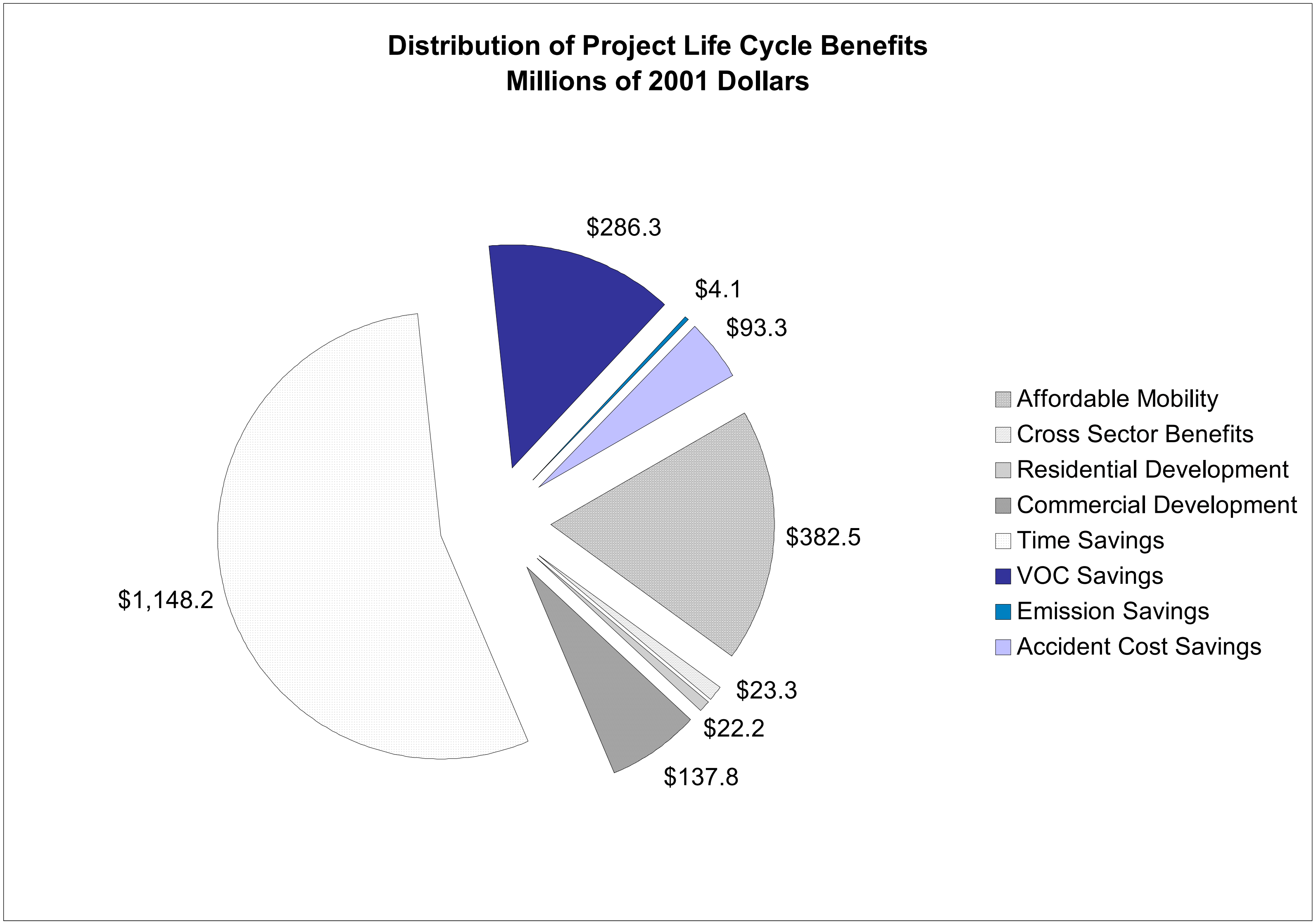
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$382.5	$260.2	$489.4	18.2%
Cross Sector Benefits	$23.3	$6.6	$47.8	1.1%
Total Low Income Mobility	**$405.8**	**$266.8**	**$537.2**	**19.3%**
Livable Community				
Residential Development	$22.2	$9.6	$35.9	1.1%
Commercial Development	$137.8	$90.4	$199.4	6.6%
Total Livable Community Benefits	**$159.9**	**$100.0**	**$235.3**	**7.6%**
Congestion Management				
Time Savings	$1,148.2	$564.8	$1,722.8	54.7%
VOC Savings	$286.3	$213.6	$345.7	13.6%
Emission Savings	$4.1	$1.7	$6.4	0.2%
Accident Cost Savings	$93.3	$43.1	$146.7	4.4%
Total Congestion Management	**$1,532.0**	**$823.2**	**$2,221.6**	**73.0%**
Grand Total Benefits	**$2,097.7**	**$1,190.0**	**$2,994.1**	**100.0%**
Total Costs	**$919.8**	**$919.8**	**$919.8**	
Net Present Value	**$1,177.9**	**$479.9**	**$1,927.0**	
Benefit-Cost Ratio	**2.28**	**1.52**	**3.09**	
Internal Rate of Return, %	**10.38%**	**7.28%**	**13.23%**	
Payback Period, years	**12**	**9**	**16**	

TABLE 14B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$47.45	$33.20	$59.04	17.9%
Cross Sector Benefits	$2.88	$0.82	$5.86	1.1%
Total Low Income Mobility	**$50.33**	**$34.02**	**$64.90**	**19.0%**
Livable Community				
Residential Development	$3.39	$1.48	$5.49	1.3%
Commercial Development	$21.01	$13.22	$29.78	7.9%
Total Livable Community Benefits	**$24.40**	**$14.71**	**$35.27**	**9.2%**
Congestion Management				
Time Saving (min. per door-to-door trip)	40.2	20.8	51.6	--
Time Savings	$141.04	$55.38	$223.92	53.1%
VOC Savings	$37.55	$26.84	$45.87	14.1%
Emission Savings	$0.49	$0.23	$0.70	0.2%
Accident Cost Savings	$11.62	$5.32	$18.26	4.4%
Total Congestion Management	**$190.69**	**$87.77**	**$288.74**	**71.8%**
Grand Total Benefits	**$265.43**	**$136.50**	**$388.91**	**100.0%**

Scenario 14: SR-51 LRT

Exhibit 14



Scenario 15: BNSF Commuter Rail

TABLE 15A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

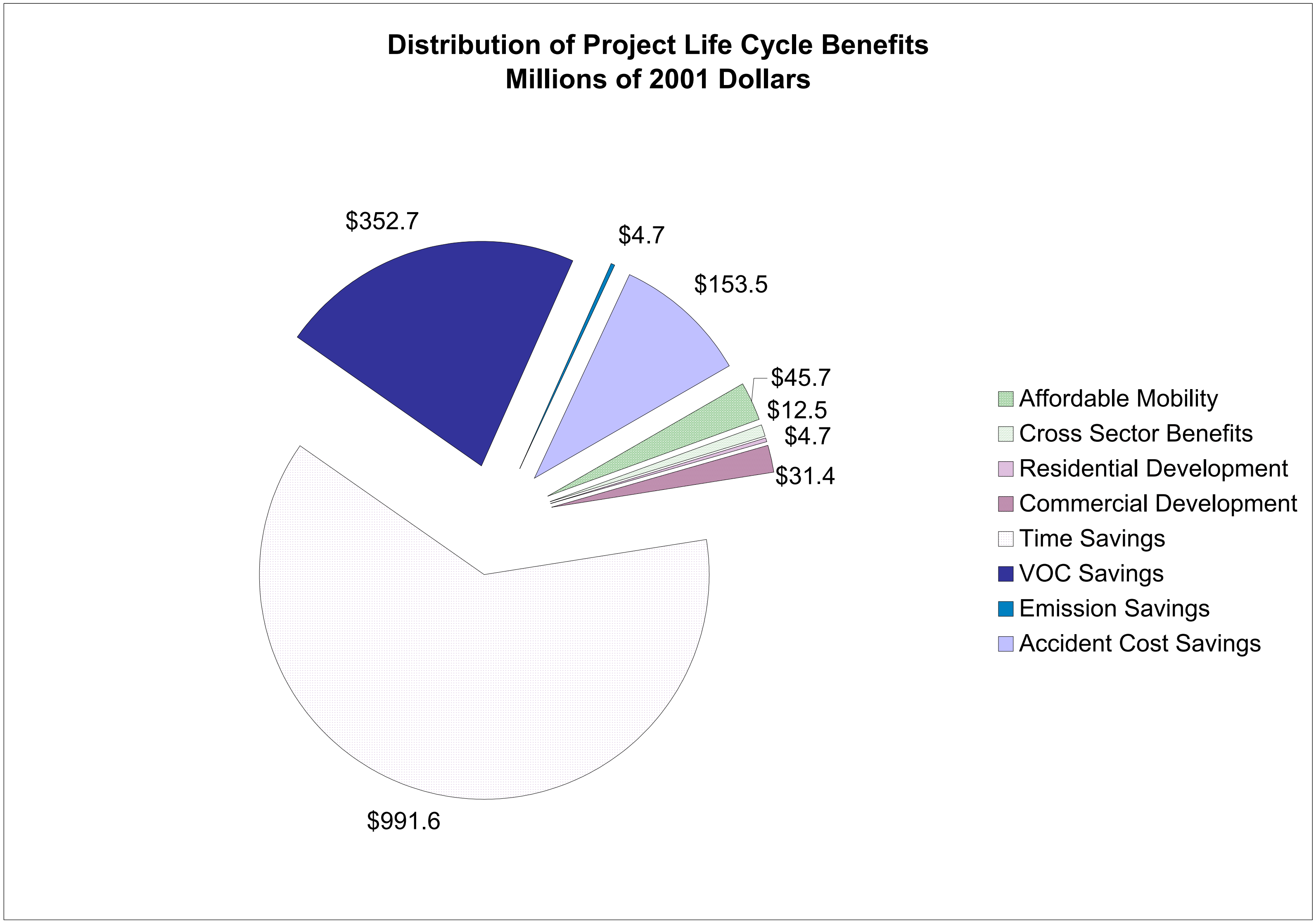
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$45.7	$25.2	$75.7	2.9%
Cross Sector Benefits	$12.5	$3.6	$25.7	0.8%
Total Low Income Mobility	**$58.2**	**$28.8**	**$101.4**	**3.6%**
Livable Community				
Residential Development	$4.7	$2.0	$7.7	0.3%
Commercial Development	$31.4	$21.4	$45.9	2.0%
Total Livable Community Benefits	**$36.1**	**$23.4**	**$53.6**	**2.3%**
Congestion Management				
Time Savings	$991.6	$415.3	$1,617.7	62.1%
VOC Savings	$352.7	$264.6	$420.9	22.1%
Emission Savings	$4.7	$2.0	$7.3	0.3%
Accident Cost Savings	$153.5	$83.7	$237.9	9.6%
Total Congestion Management	**$1,502.5**	**$765.5**	**$2,283.8**	**94.1%**
Grand Total Benefits	**$1,596.9**	**$817.7**	**$2,438.8**	**100.0%**
Total Costs	**$944.5**	**$944.5**	**$944.5**	
Net Present Value	**$652.4**	**$59.8**	**$1,328.1**	
Benefit-Cost Ratio	**1.69**	**1.06**	**2.41**	
Internal Rate of Return, %	**7.91%**	**4.54%**	**11.38%**	
Payback Period, years	**16**	**11**	**21**	

TABLE 15B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$5.68	$3.15	$9.73	3.0%
Cross Sector Benefits	$1.55	$0.44	$3.15	0.8%
Total Low Income Mobility	**$7.23**	**$3.59**	**$12.88**	**3.9%**
Livable Community				
Residential Development	$0.71	$0.30	$1.17	0.4%
Commercial Development	$4.78	$3.00	$6.93	2.6%
Total Livable Community Benefits	**$5.49**	**$3.30**	**$8.09**	**2.9%**
Congestion Management				
Time Saving (min. per door-to-door trip)	48.0	24.2	68.4	--
Time Savings	$110.73	$41.43	$167.41	59.3%
VOC Savings	$43.50	$33.25	$50.84	23.3%
Emission Savings	$0.53	$0.27	$0.76	0.3%
Accident Cost Savings	$19.17	$10.27	$30.18	10.3%
Total Congestion Management	**$173.93**	**$85.21**	**$249.19**	**93.2%**
Grand Total Benefits	**$186.65**	**$92.10**	**$270.16**	**100.0%**

Scenario 15: BNSF Commuter Rail

Exhibit 15



Scenario 16: UP Yuma Commuter Rail

TABLE 16A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

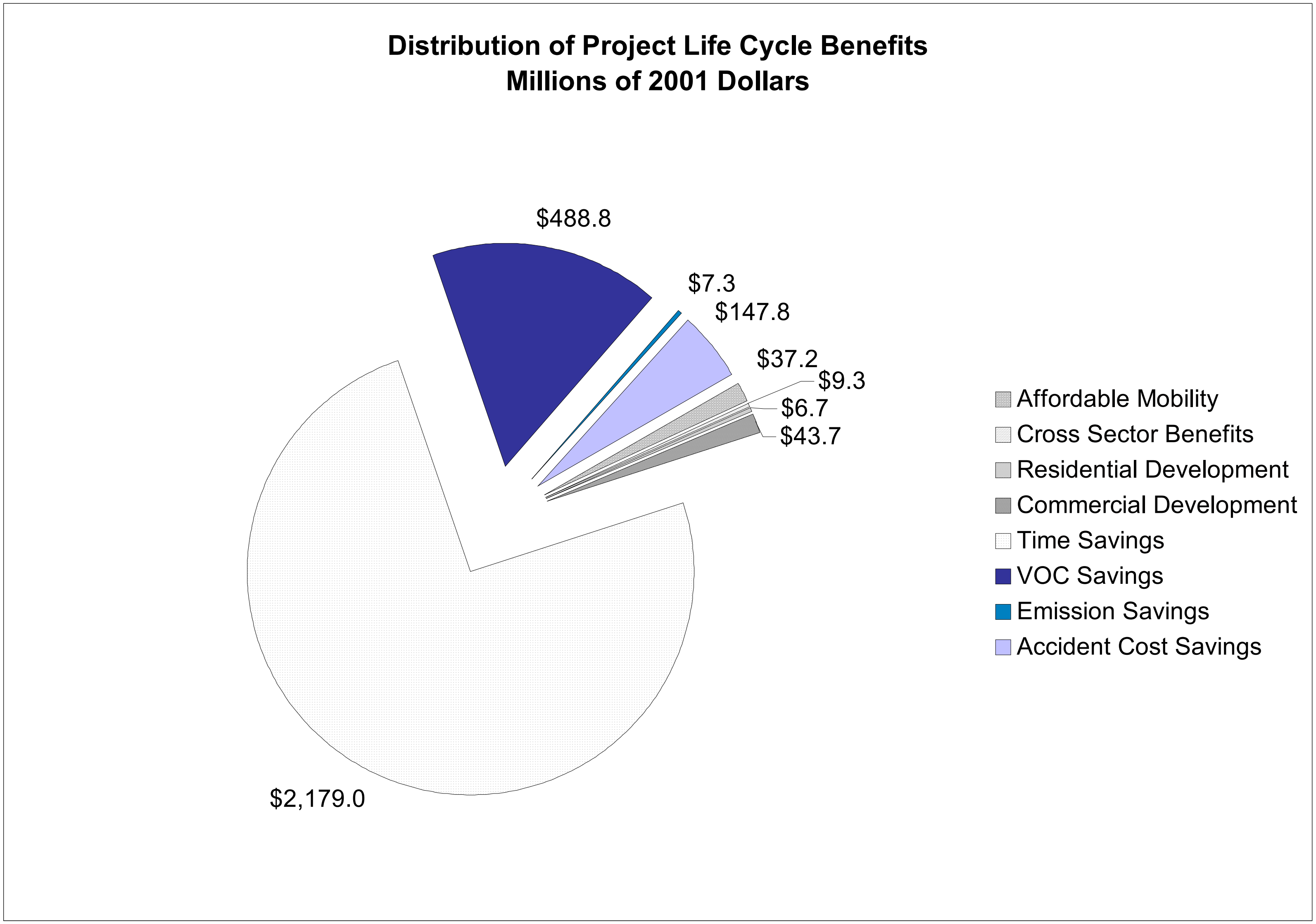
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$37.2	$21.2	$60.6	1.3%
Cross Sector Benefits	$9.3	$2.7	$19.2	0.3%
Total Low Income Mobility	**$46.6**	**$23.9**	**$79.7**	**1.6%**
Livable Community				
Residential Development	$6.7	$2.9	$11.0	0.2%
Commercial Development	$43.7	$28.8	$64.2	1.5%
Total Livable Community Benefits	**$50.5**	**$31.7**	**$75.1**	**1.7%**
Congestion Management				
Time Savings	$2,179.0	$1,304.3	$3,121.7	74.6%
VOC Savings	$488.8	$395.6	$574.4	16.7%
Emission Savings	$7.3	$3.1	$10.8	0.3%
Accident Cost Savings	$147.8	$76.4	$236.2	5.1%
Total Congestion Management	**$2,822.9**	**$1,779.5**	**$3,943.1**	**96.7%**
Grand Total Benefits	**$2,919.9**	**$1,835.0**	**$4,098.0**	**100.0%**
Total Costs	**$696.9**	**$696.9**	**$696.9**	
Net Present Value	**$2,223.0**	**$1,216.3**	**$3,305.4**	
Benefit-Cost Ratio	**4.19**	**2.75**	**5.74**	
Internal Rate of Return, %	**18.26%**	**13.13%**	**23.78%**	
Payback Period, years	7	4	10	

TABLE 16B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$4.62	$2.61	$7.67	1.2%
Cross Sector Benefits	$1.16	$0.33	$2.35	0.3%
Total Low Income Mobility	**$5.78**	**$2.94**	**$10.02**	**1.5%**
Livable Community				
Residential Development	$1.02	$0.44	$1.67	0.3%
Commercial Development	$6.66	$4.39	$9.82	1.8%
Total Livable Community Benefits	**$7.68**	**$4.83**	**$11.48**	**2.0%**
Congestion Management				
Time Saving (min. per door-to-door trip)	39.9	24.5	46.6	--
Time Savings	$280.47	$133.99	$402.76	73.8%
VOC Savings	$66.64	$52.49	$80.21	17.5%
Emission Savings	$0.89	$0.47	$1.20	0.2%
Accident Cost Savings	$18.41	$9.44	$29.40	4.8%
Total Congestion Management	**$366.40**	**$196.38**	**$513.57**	**96.5%**
Grand Total Benefits	**$379.86**	**$204.16**	**$535.08**	**100.0%**

Scenario 16: UP Yuma Commuter Rail

Exhibit 16



Scenario 17: UP SE Commuter Rail

TABLE 17A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

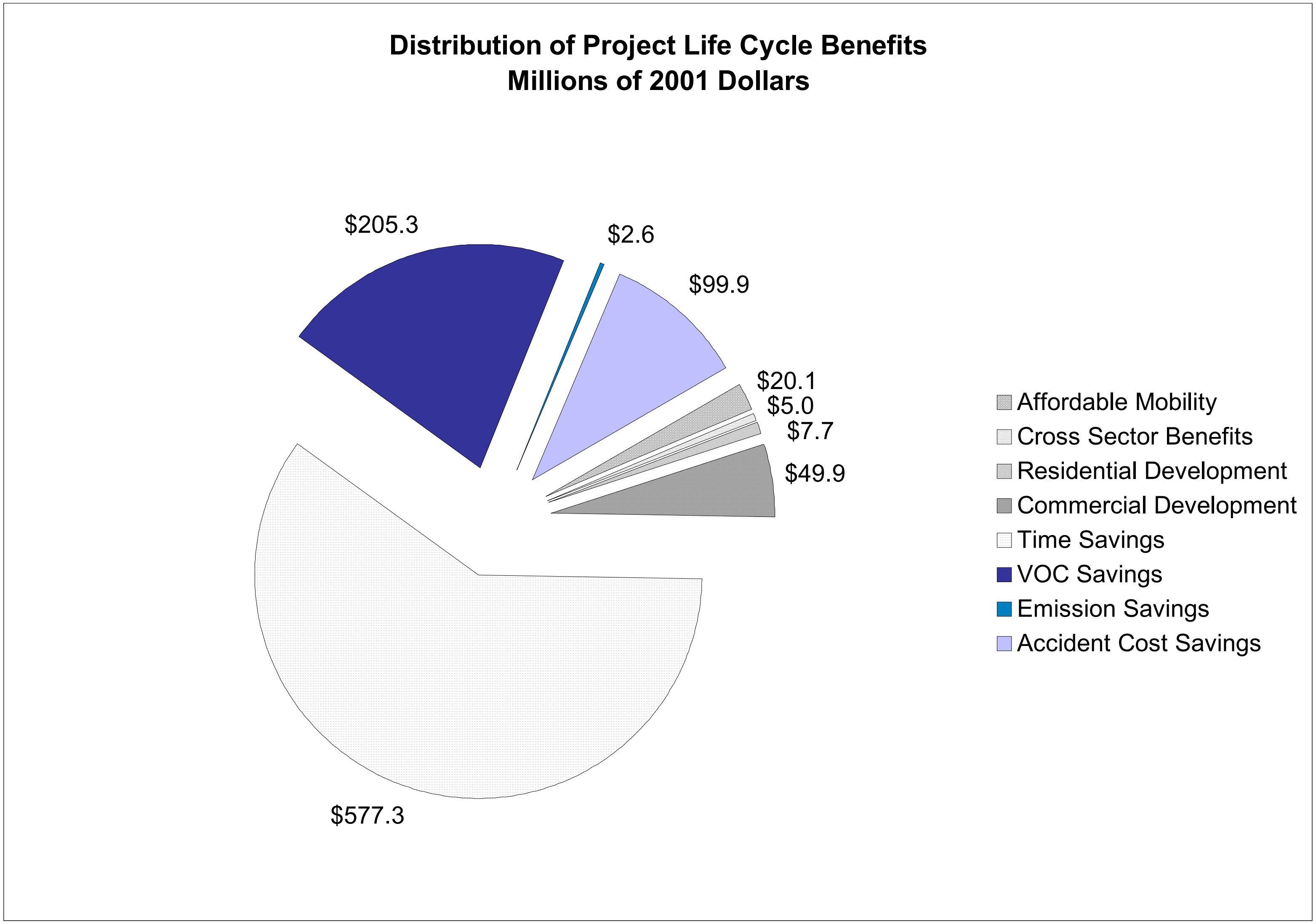
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$20.1	$11.5	$32.8	2.1%
Cross Sector Benefits	$5.0	$1.4	$10.3	0.5%
Total Low Income Mobility	**$25.1**	**$12.9**	**$43.1**	**2.6%**
Livable Community				
Residential Development	$7.7	$3.3	$12.6	0.8%
Commercial Development	$49.9	$34.1	$73.5	5.2%
Total Livable Community Benefits	**$57.6**	**$37.5**	**$86.1**	**6.0%**
Congestion Management				
Time Savings	$577.3	$199.3	$1,008.2	59.6%
VOC Savings	$205.3	$147.4	$250.9	21.2%
Emission Savings	$2.6	$1.1	$4.1	0.3%
Accident Cost Savings	$99.9	$54.8	$148.7	10.3%
Total Congestion Management	**$885.2**	**$402.6**	**$1,411.9**	**91.5%**
Grand Total Benefits	**$967.9**	**$452.9**	**$1,541.1**	**100.0%**
Total Costs	**$743.6**	**$743.6**	**$743.6**	
Net Present Value	**$224.4**	**($180.6)**	**$743.0**	
Benefit-Cost Ratio	**1.30**	**0.76**	**2.00**	
Internal Rate of Return, %	**5.46%**	**1.90%**	**9.03%**	
Payback Period, years	**20**	**15**	**23**	

TABLE 17B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$2.49	$1.39	$4.16	2.3%
Cross Sector Benefits	$0.62	$0.18	$1.26	0.6%
Total Low Income Mobility	**$3.12**	**$1.57**	**$5.42**	**2.9%**
Livable Community				
Residential Development	$1.18	$0.51	$1.92	1.1%
Commercial Development	$7.60	$5.01	$11.16	7.1%
Total Livable Community Benefits	**$8.78**	**$5.52**	**$13.07**	**8.2%**
Congestion Management				
Time Saving (min. per door-to-door trip)	37.3	10.6	68.9	--
Time Savings	$57.78	$12.28	$109.41	54.2%
VOC Savings	$24.10	$15.81	$31.83	22.6%
Emission Savings	$0.28	$0.12	$0.41	0.3%
Accident Cost Savings	$12.45	$6.62	$19.49	11.7%
Total Congestion Management	**$94.62**	**$34.83**	**$161.13**	**88.8%**
Grand Total Benefits	**$106.52**	**$41.91**	**$179.63**	**100.0%**

Scenario 17: UP SE Commuter Rail

Exhibit 17



Scenario 18: Central Avenue South

TABLE 18A: PROJECT LIFE CYCLE BENEFITS
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

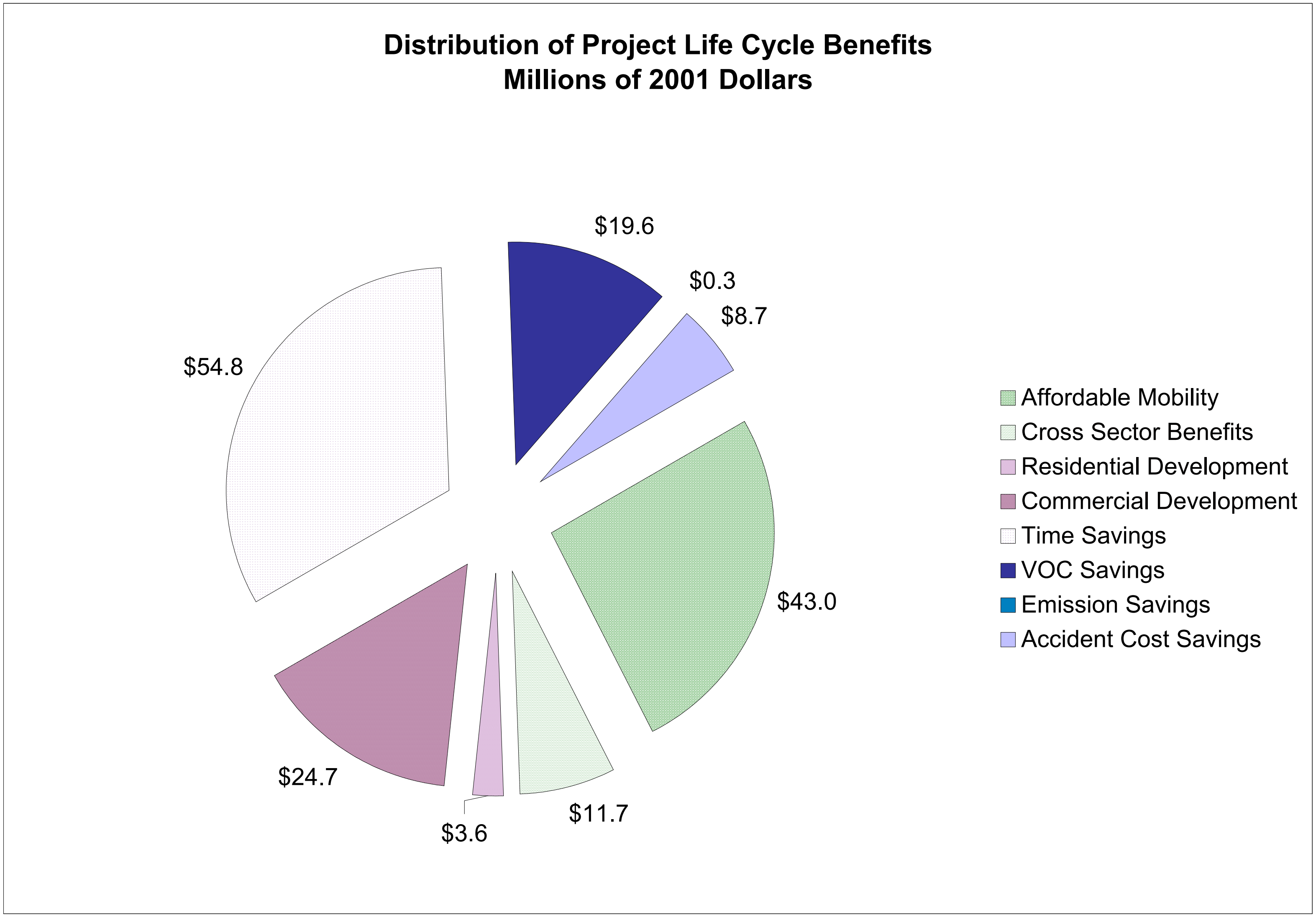
	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$43.0	$30.7	$57.0	25.9%
Cross Sector Benefits	$11.7	$4.4	$21.4	7.0%
Total Low Income Mobility	**$54.7**	**$35.1**	**$78.4**	**32.9%**
Livable Community				
Residential Development	$3.6	$1.3	$6.3	2.1%
Commercial Development	$24.7	$12.9	$39.4	14.8%
Total Livable Community Benefits	**$28.2**	**$14.2**	**$45.7**	**17.0%**
Congestion Management				
Time Savings	$54.8	$18.2	$96.5	32.9%
VOC Savings	$19.6	$13.2	$26.2	11.8%
Emission Savings	$0.3	$0.1	$0.4	0.2%
Accident Cost Savings	$8.7	$3.7	$15.0	5.2%
Total Congestion Management	**$83.4**	**$35.2**	**$138.1**	**50.1%**
Grand Total Benefits	**$166.4**	**$84.5**	**$262.2**	**100.0%**
Total Costs	**$335.0**	**$335.0**	**$335.0**	
Net Present Value	**($168.6)**	**($218.5)**	**($111.2)**	
Benefit-Cost Ratio	**0.50**	**0.35**	**0.67**	
Internal Rate of Return, %	**-3.82%**	**-8.45%**	**0.15%**	
Payback Period, years	**23**	**23**	**23**	

TABLE 18B: BENEFITS IN STEADY STATE YEAR
MILLIONS OF DOLLARS OF 2001, UNLESS SPECIFIED OTHERWISE
4% REAL DISCOUNT RATE

	Mean	Lower 10%	Upper 10%	%Total
Low Income Mobility				
Affordable Mobility	$5.34	$3.82	$7.11	26.7%
Cross Sector Benefits	$1.45	$0.51	$2.67	7.3%
Total Low Income Mobility	**$6.79**	**$4.33**	**$9.78**	**33.9%**
Livable Community				
Residential Development	$0.54	$0.20	$0.95	2.7%
Commercial Development	$3.74	$1.91	$6.27	18.7%
Total Livable Community Benefits	**$4.28**	**$2.11**	**$7.22**	**21.4%**
Congestion Management				
Time Saving (min. per door-to-door trip)	4.2	1.0	8.3	--
Time Savings	$5.53	$1.11	$11.35	27.6%
VOC Savings	$2.30	$1.41	$3.36	11.5%
Emission Savings	$0.03	$0.01	$0.05	0.1%
Accident Cost Savings	$1.08	$0.44	$1.81	5.4%
Total Congestion Management	**$8.95**	**$2.98**	**$16.56**	**44.7%**
Grand Total Benefits	**$20.02**	**$9.43**	**$33.56**	**100.0%**

Scenario 18: Central Avenue South LRT

Exhibit 18



SECTION 2: ASSUMPTIONS

Scenario 1: Camelback Road LRT

TABLE 1C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	5.9	5.9	5.9
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	8.5	8.5	8.5
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	190	190	190
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	17.5	17.5	17.5
Opening Year Highway Travel Time, minutes	54.8	54.8	54.8
Opening Year Congestion Index	1.0	1.0	1.0
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$8.50	$8.50	$8.50
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	43,520	43,520	43,520
Nb. of Commercial Properties within Area of Impact	8,704	8,704	8,704
Project Costs			
Total Vehicle Costs, $M of 2001	$60.9	$60.9	$60.9
Total Capital Costs w/o Vehicles, $M of 2001	$288.5	$288.5	$288.5
Annual OM Costs, $M of 2001	$7.6	$7.6	$7.6

Scenario 2: UP Chandler Branch LRT

TABLE 2C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	9.1	9.1	9.1
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	13.5	13.5	13.5
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	237.23	237.23	237.23
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	26.5	26.5	26.5
Opening Year Highway Travel Time, minutes	33.0	33.0	33.0
Opening Year Congestion Index	0.7	0.7	0.7
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$13.50	$13.50	$13.50
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	69,120	69,120	69,120
Nb. of Commercial Properties within Area of Impact	13,824	13,824	13,824
Project Costs			
Total Vehicle Costs, $M of 2001	$82.9	$82.9	$82.9
Total Capital Costs w/o Vehicles, $M of 2001	$378.0	$378.0	$378.0
Annual OM Costs, $M of 2001	$10.4	$10.4	$10.4

Scenario 3: Main Street (Option 2) LRT

TABLE 3C: SUMMARY OF ASSUMPTIONS

General Assumptions	**MEDIAN**	**LOWER 10%**	**UPPER 10%**
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	7.1	7.1	7.1
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	11	11	11
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	138.314	138.314	138.314
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	22.0	22.0	22.0
Opening Year Highway Travel Time, minutes	25.8	25.8	25.8
Opening Year Congestion Index	0.7	0.7	0.7
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$11.00	$11.00	$11.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	56,320	56,320	56,320
Nb. of Commercial Properties within Area of Impact	11,264	11,264	11,264
Project Costs			
Total Vehicle Costs, $M of 2001	$73.4	$73.4	$73.4
Total Capital Costs w/o Vehicles, $M of 2001	$300.2	$300.2	$300.2
Annual OM Costs, $M of 2001	$9.0	$9.0	$9.0

Scenario 4: Main Street (Option 2) BRT

TABLE 4C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	7.1	7.1	7.1
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	11	11	11
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	138.314	138.314	138.314
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	22.0	22.0	22.0
Opening Year Highway Travel Time, minutes	25.8	25.8	25.8
Opening Year Congestion Index	0.7	0.7	0.7
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$11.00	$11.00	$11.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.25	0.25	0.25
Nb. of Residential Properties within Area of Impact	28,160	28,160	28,160
Nb. of Commercial Properties within Area of Impact	5,632	5,632	5,632
Project Costs			
Total Vehicle Costs, $M of 2001	$19.6	$19.6	$19.6
Total Capital Costs w/o Vehicles, $M of 2001	$174.9	$174.9	$174.9
Annual OM Costs, $M of 2001	$5.4	$5.4	$5.4

Scenario 5: Metrocenter LRT

TABLE 5C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	6.5	6.5	6.5
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	9	9	9
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	626.718	626.718	626.718
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	11.0	11.0	11.0
Opening Year Highway Travel Time, minutes	58.6	58.6	58.6
Opening Year Congestion Index	1.0	1.0	1.0
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$9.00	$9.00	$9.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	46,080	46,080	46,080
Nb. of Commercial Properties within Area of Impact	9,216	9,216	9,216
Project Costs			
Total Vehicle Costs, $M of 2001	$61.0	$61.0	$61.0
Total Capital Costs w/o Vehicles, $M of 2001	$276.6	$276.6	$276.6
Annual OM Costs, $M of 2001	$7.6	$7.6	$7.6

Scenario 6: Glendale Avenue LRT

TABLE 6C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	5.3	5.3	5.3
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	9	9	9
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	197.599	197.599	197.599
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	18.0	18.0	18.0
Opening Year Highway Travel Time, minutes	77.0	77.0	77.0
Opening Year Congestion Index	1.0	1.0	1.0
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$9.00	$9.00	$9.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	46,080	46,080	46,080
Nb. of Commercial Properties within Area of Impact	9,216	9,216	9,216
Project Costs			
Total Vehicle Costs, $M of 2001	$73.7	$73.7	$73.7
Total Capital Costs w/o Vehicles, $M of 2001	$355.5	$355.5	$355.5
Annual OM Costs, $M of 2001	$9.0	$9.0	$9.0

Scenario 7: 59th Avenue LRT

TABLE 7C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	9.4	9.4	9.4
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	19	19	19
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	370.212	370.212	370.212
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	39.0	39.0	39.0
Opening Year Highway Travel Time, minutes	113.0	113.0	113.0
Opening Year Congestion Index	0.9	0.9	0.9
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$19.00	$19.00	$19.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	97,280	97,280	97,280
Nb. of Commercial Properties within Area of Impact	19,456	19,456	19,456
Project Costs			
Total Vehicle Costs, $M of 2001	$84.7	$84.7	$84.7
Total Capital Costs w/o Vehicles, $M of 2001	$643.1	$643.1	$643.1
Annual OM Costs, $M of 2001	$11.3	$11.3	$11.3

Scenario 8: 59th Avenue BRT

TABLE 8C: SUMMARY OF ASSUMPTIONS

General Assumptions	**MEDIAN**	**LOWER 10%**	**UPPER 10%**
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	9.4	9.4	9.4
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	19	19	19
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	370.212	370.212	370.212
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	39.0	39.0	39.0
Opening Year Highway Travel Time, minutes	113.0	113.0	113.0
Opening Year Congestion Index	0.9	0.9	0.9
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$19.00	$19.00	$19.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.25	0.25	0.25
Nb. of Residential Properties within Area of Impact	48,640	48,640	48,640
Nb. of Commercial Properties within Area of Impact	9,728	9,728	9,728
Project Costs			
Total Vehicle Costs, $M of 2001	$36.7	$36.7	$36.7
Total Capital Costs w/o Vehicles, $M of 2001	$340.7	$340.7	$340.7
Annual OM Costs, $M of 2001	$10.3	$10.3	$10.3

Scenario 9: Bell Road LRT

TABLE 9C: SUMMARY OF ASSUMPTIONS

General Assumptions	**MEDIAN**	**LOWER 10%**	**UPPER 10%**
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	14.4	14.4	14.4
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	28.5	28.5	28.5
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	702.146	702.146	702.146
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	54.0	54.0	54.0
Opening Year Highway Travel Time, minutes	155.3	155.3	155.3
Opening Year Congestion Index	0.9	0.9	0.9
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$28.50	$28.50	$28.50
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	145,920	145,920	145,920
Nb. of Commercial Properties within Area of Impact	29,184	29,184	29,184
Project Costs			
Total Vehicle Costs, $M of 2001	$179.3	$179.3	$179.3
Total Capital Costs w/o Vehicles, $M of 2001	$923.0	$923.0	$923.0
Annual OM Costs, $M of 2001	$22.6	$22.6	$22.6

Scenario 10: Chandler Boulevard LRT

TABLE 10C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	8.9	8.9	8.9
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	19.5	19.5	19.5
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	332.135	332.135	332.135
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	38.5	38.5	38.5
Opening Year Highway Travel Time, minutes	57.0	57.0	57.0
Opening Year Congestion Index	0.7	0.7	0.7
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$19.50	$19.50	$19.50
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	99,840	99,840	99,840
Nb. of Commercial Properties within Area of Impact	19,968	19,968	19,968
Project Costs			
Total Vehicle Costs, $M of 2001	$75.6	$75.6	$75.6
Total Capital Costs w/o Vehicles, $M of 2001	$608.1	$608.1	$608.1
Annual OM Costs, $M of 2001	$9.7	$9.7	$9.7

Scenario 11: I-10 West LRT

TABLE 11C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	10.0	10.0	10.0
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	10.5	10.5	10.5
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	1018.838	1018.838	1018.838
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	11.3	11.3	11.3
Opening Year Highway Travel Time, minutes	96.6	96.6	96.6
Opening Year Congestion Index	1.0	1.0	1.0
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$10.50	$10.50	$10.50
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	53,760	53,760	53,760
Nb. of Commercial Properties within Area of Impact	10,752	10,752	10,752
Project Costs			
Total Vehicle Costs, $M of 2001	$82.4	$82.4	$82.4
Total Capital Costs w/o Vehicles, $M of 2001	$316.9	$316.9	$316.9
Annual OM Costs, $M of 2001	$10.3	$10.3	$10.3

Scenario 12: Power Road LRT

TABLE 12C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	6.3	6.3	6.3
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	13	13	13
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	162.724	162.724	162.724
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	24.5	24.5	24.5
Opening Year Highway Travel Time, minutes	28.3	28.3	28.3
Opening Year Congestion Index	0.7	0.7	0.7
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$13.00	$13.00	$13.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	66,560	66,560	66,560
Nb. of Commercial Properties within Area of Impact	13,312	13,312	13,312
Project Costs			
Total Vehicle Costs, $M of 2001	$53.8	$53.8	$53.8
Total Capital Costs w/o Vehicles, $M of 2001	$411.3	$411.3	$411.3
Annual OM Costs, $M of 2001	$8.3	$8.3	$8.3

Scenario 13: Scottsdale/UP Tempe LRT

TABLE 13C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	15.1	15.1	15.1
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	24.5	24.5	24.5
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	541.888	541.888	541.888
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	50.0	50.0	50.0
Opening Year Highway Travel Time, minutes	144.5	144.5	144.5
Opening Year Congestion Index	0.9	0.9	0.9
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$24.50	$24.50	$24.50
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	125,440	125,440	125,440
Nb. of Commercial Properties within Area of Impact	25,088	25,088	25,088
Project Costs			
Total Vehicle Costs, $M of 2001	$165.9	$165.9	$165.9
Total Capital Costs w/o Vehicles, $M of 2001	$844.9	$844.9	$844.9
Annual OM Costs, $M of 2001	$21.0	$21.0	$21.0

Scenario 14: SR-51 LRT

TABLE 14C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	9.0	9.0	9.0
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	23	23	23
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	845.839	845.839	845.839
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	32.0	32.0	32.0
Opening Year Highway Travel Time, minutes	156.3	156.3	156.3
Opening Year Congestion Index	1.0	1.0	1.0
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$23.00	$23.00	$23.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	117,760	117,760	117,760
Nb. of Commercial Properties within Area of Impact	23,552	23,552	23,552
Project Costs			
Total Vehicle Costs, $M of 2001	$113.5	$113.5	$113.5
Total Capital Costs w/o Vehicles, $M of 2001	$709.8	$709.8	$709.8
Annual OM Costs, $M of 2001	$14.3	$14.3	$14.3

Scenario 15: BNSF Commuter Rail

TABLE 15C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	9.7	9.7	9.7
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	75.0	70.0	80.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	23	23	23
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	646.457	646.457	646.457
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	44.0	44.0	44.0
Opening Year Highway Travel Time, minutes	197.5	197.5	197.5
Opening Year Congestion Index	1.0	1.0	1.0
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$2.99	$2.99	$2.99
Avg. Fare - Taxi, $	$23.00	$23.00	$23.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	20.0	15.0	25.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	29,440	29,440	29,440
Nb. of Commercial Properties within Area of Impact	5,888	5,888	5,888
Project Costs			
Total Vehicle Costs, $M of 2001	$170.3	$170.3	$170.3
Total Capital Costs w/o Vehicles, $M of 2001	$571.3	$571.3	$571.3
Annual OM Costs, $M of 2001	$22.6	$22.6	$22.6

Scenario 16: UP Yuma Commuter Rail

TABLE 16C: SUMMARY OF ASSUMPTIONS

General Assumptions	**MEDIAN**	**LOWER 10%**	**UPPER 10%**
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	7.2	7.2	7.2
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	75.0	70.0	80.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	31	31	31
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	2178.306	2178.306	2178.306
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	31.0	31.0	31.0
Opening Year Highway Travel Time, minutes	211.0	211.0	211.0
Opening Year Congestion Index	1.0	1.0	1.0
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$3.50	$3.50	$3.50
Avg. Fare - Taxi, $	$31.00	$31.00	$31.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	20.0	15.0	25.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	39,680	39,680	39,680
Nb. of Commercial Properties within Area of Impact	7,936	7,936	7,936
Project Costs			
Total Vehicle Costs, $M of 2001	$176.0	$176.0	$176.0
Total Capital Costs w/o Vehicles, $M of 2001	$295.7	$295.7	$295.7
Annual OM Costs, $M of 2001	$22.4	$22.4	$22.4

Scenario 17: UP SE Commuter Rail

TABLE 17C: SUMMARY OF ASSUMPTIONS FOR SCENARIO

General Assumptions	**MEDIAN**	**LOWER 10%**	**UPPER 10%**
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	3.9	3.9	3.9
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	75.0	70.0	80.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	35	35	35
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	589.168	589.168	589.168
VMT Annual Growth Period 1, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	70.0	70.0	70.0
Opening Year Highway Travel Time, minutes	129.6	129.6	129.6
Opening Year Congestion Index	0.9	0.9	0.9
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$3.94	$3.94	$3.94
Avg. Fare - Taxi, $	$35.00	$35.00	$35.00
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	20.0	15.0	25.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	44,800	44,800	44,800
Nb. of Commercial Properties within Area of Impact	8,960	8,960	8,960
Project Costs			
Total Vehicle Costs, $M of 2001	$162.6	$162.6	$162.6
Total Capital Costs w/o Vehicles, $M of 2001	$446.3	$446.3	$446.3
Annual OM Costs, $M of 2001	$16.1	$16.1	$16.1

Scenario 18: Central Avenue South LRT

TABLE 18C: SUMMARY OF ASSUMPTIONS

General Assumptions	MEDIAN	LOWER 10%	UPPER 10%
Real Discount Rate, %	4.0	4.0	4.0
Avg. Annual Inflation Period 1, %	2.5	2.0	3.0
Avg. Annual Inflation Period 2, %	2.5	2.0	3.0
Avg. Annual Inflation Period 3, %	2.5	2.0	3.0
Avg. Annual Inflation Period 4, %	2.5	2.0	3.0
Avg. Value of Time, $/hour	$13.60	$11.60	$17.70
Projected Ridership			
Daily Ridership in Opening Year, thousands	4.197	4.197	4.197
Avg. Annual Ridership Growth Period 1, %	13.6	13.6	13.6
Avg. Annual Ridership Growth Period 2, %	2.0	1.0	3.0
Avg. Annual Ridership Growth Period 3, %	2.0	1.0	3.0
Perc. of Trips Diverted from Auto, %	50.0	40.0	60.0
Perc. of Ridership in PEAK Time, %	60.0	60.0	60.0
Avg. Trip Length, miles	4.5	4.5	4.5
Highway Traffic			
First Year Vehicle Miles Traveled, thousands	64.454	64.454	64.454
VMT Annual Growth, %	1.0	0.5	1.5
Free Flow Highway Travel Time, minutes	9.0	9.0	9.0
Opening Year Highway Travel Time, minutes	17.8	17.8	17.8
Opening Year Congestion Index	0.9	0.9	0.9
Highway User Costs			
Fuel Cost, $/gallon	$1.38	$1.16	$1.66
Oil Cost, $/quart	$4.14	$3.51	$4.94
Tire Cost, $	$72.64	$61.02	$86.71
Maintenance and Repair Cost, $	$118.45	$98.28	$142.34
Avg. Vehicle Depreciable Value, $T	$20.74	$16.59	$24.89
Fatal Accident Cost, $T/accident	$3,495.91	$803.21	$8,038.88
Injury Accident Cost, $T/accident	$30.94	$5.51	$79.96
Property Damage Cost, $T/accident	$2.63	$0.65	$5.31
NOX Cost, $/ton	$4,361.16	$2,582.83	$6,139.50
VOC Cost, $/ton	$3,224.72	$1,785.11	$4,664.33
SOX Cost, $/ton	$8,469.97	$2,711.54	$14,228.40
PM2.5 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
PM10 Cost, $/ton	$4,089.61	$2,734.69	$5,444.54
CO Cost, $/ton	$67.75	$22.58	$112.91
CO2 Cost, $/ton	$25.00	$13.00	$38.00
Affordable Mobility			
Avg. Fare - Transit, $	$0.66	$0.66	$0.66
Avg. Fare - Taxi, $	$4.50	$4.50	$4.50
Avg. Parking Cost, $	$7.00	$5.00	$12.00
Perc. of Low Income People in Total Ridership, %	40.0	30.0	50.0
Perc. of Trips for Medical Purposes, %	15.0	10.0	20.0
Perc. of Trips for Work Purposes, %	55.0	50.0	60.0
Perc. of Lost Medical Trips leading to Home Care, %	10.0	5.0	15.0
Perc. of Lost Work Trips leading to Unemployment, %	5.0	2.5	10.0
Community Development			
Development Area, mile radius	0.50	0.50	0.50
Nb. of Residential Properties within Area of Impact	23,040	23,040	23,040
Nb. of Commercial Properties within Area of Impact	4,608	4,608	4,608
Project Costs			
Total Vehicle Costs, $M of 2001	$43.1	$43.1	$43.1
Total Capital Costs w/o Vehicles, $M of 2001	$184.9	$184.9	$184.9
Annual OM Costs, $M of 2001	$10.4	$10.4	$10.4

Appendix E